*** MENLO PARK REMINISCENCES — JEHL VOL. 3

MENLO PARK REMINISCENCES

VOLUME THREE

FRANCIS JEHL

MENLO PARK

Reminiscences

By

FRANCIS JEHL

Staff laboratory assistant of
Thomas Alva Edison
at Menlo Park

VOLUME THREE

Written in
Edison's restored Menlo Park laboratory

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PART FIVE

(CHAPTERS XCI TO CVI INCLUSIVE)

Lighting of New York City

As told by
FRANCIS JEHL

FROM 1881 to 1941

FOREWORD

WHILE engaged in completing the final chapters of Volume III of his *Menlo Park Reminiscences*, Francis Jehl, sole survivor of the little group of men who had assisted Thomas Alva Edison at his invention of the practical incandescent lamp, passed away suddenly at St. Petersburg, Florida.

The irreparable loss of this distinguished Edisonian came as a shock to the wide circle of associates among whom he had worked for so many years. One of the most eloquent tributes to his memory was that of the Edison Pioneers, of which organization he had been a loyal and valued member since early times; and it is included in this volume, following the final chapter.

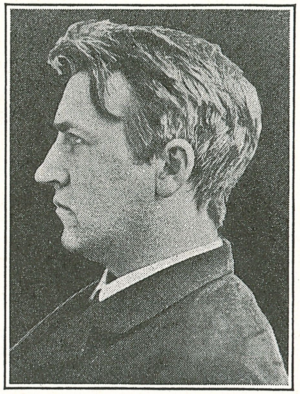
The material for his last chapter was in Mr. Jehl's hands at the time of his death, undergoing revision, and was forwarded by Mrs. Jehl to The Edison Institute. It comprises Chapter CV, and is entitled 'The Final Chapter.'

No more important contribution to the story of pioneer electrical development could have been made than the intimate day-by-day details that Mr. Jehl set down in book form, at the suggestion of Mr. Henry Ford. Already Volumes I and II of his Reminiscences—describing activities at Menlo Park; the patient, determined search for the successful lamp; and the evolution of the Edison power system—have won for themselves a lofty niche in industrial annals.

We feel sure that this third, and final, volume will be found to measure up to, and in some respects even to surpass, its predecessors.

In closing, we wish to acknowledge with deep gratitude the many expressions of regret that were received after the sad tidings of Mr. Jehl's passing were made known.

The Editor



THOMAS A. EDISON in 1881.

XCI. Sixty-five Fifth Avenue

(PART ONE)

SIXTY-FIVE Fifth Avenue, New York City, was the headquarters for The Edison Electric Light Company from the beginning of 1881 until the latter part of 1886. Here, also, Edison had his office. At that time he was the company's consulting engineer; in fact, his office was a sort of clearinghouse in all matters pertaining to his system and to his private industries as licensed by the parent, The Edison Electric Light Company.

During that period, this organization, which held all the patents pertaining to Edison's system of electric lighting, was engaged in selling rights and in assigning concessions. As it did not wish to take up the manufacture of dynamos and other parts necessary for exploitation, it entered into an agreement with Edison, whereby he pledged himself to do the manufacturing. As it was a new industry, there was no one else who could undertake it. Hence it was that Edison controlled, at the outset, the manufacture of all appliances

Taken by Anderson, 785 Broadway, New York, June 25, 1881.

necessary for the introduction of his system.

Edison, it must be mentioned, had to finance his manufacturing concerns himself, together with some of his trusted associates like Batchelor, Upton, Johnson, Kruesi, and Bergmann. The parent company thought it was the best policy to be engaged only in granting licenses and in receiving royalties under certain conditions to be enumerated later. Necessary apparatus was purchased from Edison-owned or -controlled factories.

As has been already described, The Edison Electric Light Company was organized on October 15, 1878, with a capital of $300,000.(1) By 1881, it had moved from the Boreel Building at 115 Broadway and settled down to business at 65 Fifth Avenue in a house leased from the Bishop family. It was an old-fashioned, double, brownstone residence situated one lot south of the corner of Fourteenth Street on the east side of Fifth Avenue. Fifth Avenue at that period was the most fashionable thoroughfare, and Fourteenth Street was a part of the roaring night life called 'The Tenderloin.' Delmonico's, most famous of New York's caterers, where the most jaded appetite could be satisfied, was located at Fourteenth Street and Fifth Avenue. The location of the Edison company for business and demonstrations was thus most advantageous.

An old telegraph friend, whom Edison called Johnny, visited him at Menlo Park early in February 1881.

'We are up in the world now,' said Johnny, smiling at Edison.

To which Edison replied, 'Yes, Johnny, a little money is the best balance wheel, but thank God I don't worship it.' Then, continuing, Edison related, 'Yes, ten years ago I walked the streets of New York and did not have the price of a bed and no money for breakfast in the morning. A kind tea

(1) In 1881, the stock of The Edison Electric Light Company was increased to $480,000. In 1882, it was increased again to $720,000, and in 1883, to $1,080,000.

taster(2) down at the foot of Wall Street gave me a little bag of tea and then a poor woman in the neighborhood gave me a breakfast for it. Two weeks later I was making $300 a month and now, Johnny, just think, I am going to run a whole brownstone house on Fifth Avenue as my business headquarters and move my family on the opposite side of the avenue.'

'Are you going to leave Menlo Park?' Johnny asked.

'No,' said Edison, 'it will be my country home, but I am going to close my laboratory and workshop.'

'But,' questioned his friend, 'are you fit for business?'

'I never tried until I had to,' and then Edison smilingly added, 'applesauce and industry are all right, but a man must not be a fool.'

Many people have asked me years later what the turn of events would have been if Edison had had business capacity as well as inventive genius. Well, your guess is as good as mine, but history shows that in the course of a few years Edison had all the glory, while the other fellows had control of the machine works and other factories. But he desired it so.

In the beginning, as the art was new, Menlo Parkers were required to instruct and to assist newcomers, and the first 'shock troops' that left Menlo Park on February 7, 1881, were headed by Charles L. Clarke. Edison had intrusted Clarke with the position of chief engineer and, as such, had given him charge of designing and erecting the Pearl Street Central Station. Clarke had to make shop drawings for the new generators to be manufactured by the Edison machine shop in Goerck Street. He had to organize the different technical departments necessary in starting an entirely new business.

Kruesi and some of his crew left Menlo Park a week after Clarke. Their first job was to take over a small building at 65 Washington Street, New York City, and to get it in order for the manufacture of the Edison underground electric conductors, the construction of which I have already described in my second volume of Reminiscences.(3)

Kruesi had with him in those early days a young Canadian of much ability who assisted him as a mechanical engineer

(2) A tea taster was a man who sampled the tea that was imported from the east and who fixed its value.

(3) Chapter LXXXVI, p. 848.

in getting the Edison electric underground conductors standardized and who, with Kruesi, took out two patents relating to underground conductors. His name was John Langton. The services that he rendered later in the Brooklyn shop on Bridge Street as superintendent, and in Schenectady, when the Edison works moved there, as acting chief engineer, places his name among the special pioneers in the history of the introduction of the Edison system. Clarke knew Langton from the time he served his machinist apprenticeship in the Portland (Maine) Machine Works back in the 1870's. It is unfortunate that Edisonian history has almost overlooked Langton and the services he rendered.

Another man whom Kruesi trained and who rendered good service in Europe, laying the first Edison underground conductors, was a Mr. Patterson whose given name, I think, was 'Henry C.' An able man, Patterson deserved much credit for his work.

Edison and his family left Menlo Park on February 28, 1881, and settled in a fashionable family hotel diagonally opposite the Edison headquarters, on the other side of Fifth Avenue.

The Edison headquarters was wired by Wilson S. Howell and a small power plant was installed in the basement, put into position, and operated by John H. Vail. At first an Otto gas engine was used as the prime motor, but as it fluctuated in speed enough to cause the light to vary up and down, Edison had a steam boiler set up in the yard, and the little Hampson steam engine that we had in the Menlo Park machine shop was installed instead of the Otto.

This plant not only served to provide light for the offices, but also as a continuous exhibition for the public. Visitors flocked to the Edison headquarters every night, and the crowds were fired with enthusiasm. Newspapers contained daily articles with laudatory comments about Edison and his light system.

Promoters and others interested in the system came from all parts of the country and from abroad, eagerly seeking rights to introduce the Edison system in their respective territories or countries.

The Edison lamp factory and Bergmann were ready to supply their own products, but the Edison Machine Works was not yet ready to deliver the Edison generators; the delay caused the loss of many orders for small isolated plants, and

the public began to complain. At first Edison wanted to erect central-station plants only, and not bother with isolated lighting. He soon changed his mind, for toward the end of 1881, the Edison company for isolated lighting was formed under a license from the parent company. Miller F. Moore was a very able business manager for some years. This company was consolidated with the Edison Electric Light Company on December 31, 1886.

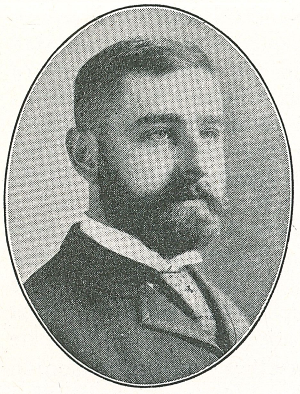
I would now like to mention some of the men who started their activities at '65,' as the Edison headquarters was generally designated by the 'boys.' As far as the technicalities of the Edison system were concerned, they were the 'first edition' of Edison Menlo Park pioneers, and assisted the newcomers in familiarizing themselves with Edisonian principles.

Clarke's chief assistant was Julius L. Hornig, an experienced mechanical and steam engineer, who came from Menlo Park where he had previously assisted Kruesi in some of the larger mechanical problems.

Hornig spent most of his time in drawing the plans of the Pearl Street Central Station, principally the steel construction parts. For instance, there was the erection of steel pillars to support lattice girders and floor beams, similar to that of the elevated railroad structure whose road passed by the central station. Upon this structure in the station, Edison planned to rest the six combined Jumbo generators and steam engines, which together weighed 180 tons. Then there were other innovations, such as traveling cranes with hoists, forced-draft blowers, feed-water heaters, screw conveyors, ash-handling apparatus, and the placement of the steam boilers, piping, and other adjuncts thought necessary.

JULIUS HORNIG

As such an audacious undertaking had never been dreamed of before, one can realize what



H. M. BYLLESBY

work there was ahead for Edison, Clarke, and Hornig when they commenced the planning of the Pearl Street station in the early part of 1881.

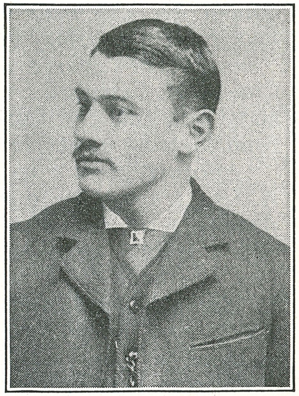
Clarke also had two outside engineers to act as advisers, C. C. Schneider and A. Schweizer. They both reported favorably regarding the solidity of the steel structure.

On June 1, 1881, Edison sent to Clarke a young man whose name was Henry Marison Byllesby,(4) with a request to put him to work. Clarke placed him with Hornig, and there Byllesby assisted as draftsman in the making of the drawings for the Pearl Street station. Byllesby was a fine mechanical engineer. Although young, he had already acquired useful experience and proved himself efficient. He was intrusted with several missions, which he carried out successfully. It soon developed that he was a go-getter. It is not necessary for me to say much about him, for in later years he held a conspicuous place in the start of the central-station utilities and finances. He left the Edison company in 1885, and from that time on, his star rose.

It is not too much to say that as an engineer, promoter, organizer, financier, and operator, Byllesby was the first and most successful one of his time. The firm that bears his name today—H. M. Byllesby & Company, Chicago, Illinois—and its holdings testify to the powers and attainments of its founder.

Another bright young man whom Clarke had in his department was John W. Lieb, a graduate of the Stevens Institute of Technology. He had acquired some early experience with the Brush Electric Company. Lieb was the first to enter Edison's employ at 65 Fifth Avenue, and assisted in making the plans of the Jumbo generators and other apparatus. Edison soon noticed the intelligent and assiduous young man, whose work was always satisfactory.

(4) Henry Marison Byllesby passed away May 1924.



J. W. Lieb when he was with Brush in Cleveland in 1880.

Lieb went through several courses in the Edison machine shop and soon mastered the technicalities from an engineer's point of view. When the Pearl Street station was being erected, he had charge of the electrical equipment. When the station was ready for operation, he was appointed its master electrician and when, toward the end of 1882, the Italian Edison Company of Milan, Italy, was ready to begin the erection of a station, Lieb was intrusted to carry out the work. He remained in Italy for twelve years and was successively appointed chief electrician, chief engineer, and finally technical manager and director of stations.

In central-station technic and development, the Pearl Street station took the lead; it was the first. The Italian station was second in point of time, but it was really first when we consider the strides incorporated there. It was the first Edison station to make use of direct and alternating current, and the first to have street arc lighting and electric trams.(5)

Professor Guiseppe Colombo and Dr. John W. Lieb are the first Edison pioneers of both direct and alternating current; their names possess a special luster in Edisonian history and in progressive pioneer developments in central-station work in connection with direct and alternating current.

Lieb's exertions were characterized through his knowledge and expert management of the largest central station of that period. His honesty and fidelity to Edison were conspicuous. We will describe more of his work later on.

Gustave Soldan was at the head of the drafting room. Clarke thought much of Soldan; he was very able. After Dean had left the Edison machine shop in Goerck Street, Soldan became the superintendent, and when Batchelor returned from Europe later on, he became the manager. Then

(5) See Vol. II, *Menlo Park Reminiscences*, p. 832

Soldan left and went with Merck and Company, medicine makers of University Place, New York City.

In Soldan's charge were about a dozen men, among them Charles H. Campbell. Clarke considered Campbell an experienced and able draftsman. He was the son of a well-known printing-press manufacturer.

Another good man working under Hornig was Joseph A. Lee, a specialist in structural steelwork. It is difficult to remember the names of all the men who were once at '65,' unless special circumstances or their abilities were taken note of among the records of those days.

Herman Claudius,(6) whom I mentioned in Volume II of *Menlo Park Reminiscences*, was also with Clarke, and was assigned to the task of calculating cross sections of the underground conductors. That method was soon abandoned, however, and he returned to Menlo Park to work on the miniature model plan of finding the positions and cross sections of the feeder conductors for central stations at a given location.

Clarke's secretary was Charles Burnham. There was considerable office work—specifications, agreements, contracts, and similar matters—to attend to. Burnham was a fine chap. Later, he became manager of a large storage warehouse on Forty-second Street, between Park and Sixth avenues. He died suddenly about 1898.

Edison, we know, desired at first to erect only central stations. When, however, the machine works at 104 Goerck Street began to turn out dynamos, members of The Edison Electric Light Company made up their minds to take up isolated plant lighting, for they saw good business prospects in that direction. It was in the latter part of 1881 that the Edison company for isolated lighting was organized as a licensee of the parent company. A good engineer and businessman was engaged as manager, Miller F. Moore. He was engaged on a salary and commission.

Under Moore's energetic management, the company prospered and fat dividends resulted. Incidentally, Moore also made fat commissions, which some did not 'eye' so cheerfully. For reasons that need no explanation, it may be said that his success caused him to resign in 1883.

Clarke told me: 'Yes, I know it. They drove out a good man. How in the devil did you learn about it? I got him

(6) Chapter LXXVI, p. 732.

for the company—hunted him up on Liberty or Cortlandt Street. He was then agent for the Bissell locomotive front truck, and its patent defender. He was an aggressive fighter. He lived to be eighty-eight.'

When the Edison company for isolated lighting was merged with the parent company in 1886, the combination was called Edison Electric Light Company, the initial 'The' being dropped. They then moved the offices to 16-18 Broad Street.

While Moore was active, he had in his office Frederick A. Scheffler, whose duties consisted of making plans of isolated plants that were to be erected. Toward the end of 1881, when Villard induced Edison to build a second electric locomotive and a longer truck, Moore was called upon to plan that work. He gave the leads to Scheffler as to what to do.

The work, as carried out, was technically on the same basis as the first locomotive of 1880, but was camouflaged with a cowcatcher, large headlights, and a bell. It also had a cab where the motorman operated, to make it appear like a regular steam-engine locomotive. Villard paid the expenses of this experimental line and locomotive of 1882, but later, it was said, Edison refunded the money. During Moore's time, he had on his staff such men as Vail, Howell, Schroeder, Doubleday, Wirt, Wardlaw, and others. Moore's department installed the first commercial isolated plants in this country.

Special mention must be made of Wilson S. Howell, whose work has already been mentioned in Volume II. When he came to New York, he was placed as head of the Marine Department, which later merged with the Edison company for isolated lighting. Howell supervised the first commercial installations on steamboats such as the S. S. *City of Worcester*, *Namouna*, and *Albatross*. In 1882-83, he erected the 330-volt experimental central station in Roselle, New Jersey.

Samuel D. Mott and Edward C. Rowland, patent draftsmen for Edison at Menlo Park, followed their chief and continued their work at '65.'

Another familiar figure at '65' was Luther Stieringer, father and creator of flood and spectacular electric glow lamp illumination, whose activities have been mentioned in Volume II.

There, too, Colonel E. T. Greenfield often could be seen, for he was head of the interior wiring department in the Pearl Street district; later, he made improvements in wiring accessories. The colonel also had an office on Ann Street, near the Pearl Street district.

THOMAS A. EDISON in 1887.

XCII. Sixty-five Fifth Avenue

(PART TWO)

SIXTY-FIVE Fifth Avenue was the rallying point of all men interested in Edison's lighting system, or those engaged in the Edison manufacturing enterprises. The parent company had been very liberal in financing Edison's series of expensive experiments at Menlo Park, but when they started in business, they expected to 'cash in' by selling States' rights and concessions at one office window, and at another, handing over concessions. They found that running a business was something different from jurisprudence or finances.

Yes, the best lawyers and the greatest financiers were interested in The Edison Electric Light Company, but they, too, had to learn that a revolutionary enterprise must be guided with patience, and that it was not to be judged immediately by the red- and black-ink columns in the ledger. The engineer, technician, and manufacturer had to lead first; without them the concessions would not amount to much. To get into action required time.

Then again, the parent company at the start had hardly

visioned the enormous possibilities Edison's system held for the future. Nor did they imagine that they would have to contest their rights against pirates at home and abroad, with enormous cost. A live-wire manager was badly needed. If they had heeded the advice of the secretary, Colonel Calvin Goddard, they would have fared better.

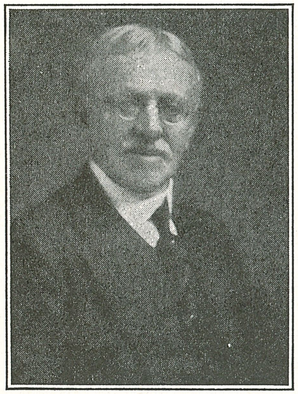
When the company started in 1881, Norvin Green was its president, but he did not have time to attend to its business, as he was also president of the Western Union Telegraph Company. He soon resigned.

Major Sherburne B. Eaton was the general manager and vice-president, although he had not the temperament for a manager. He was a prominent lawyer and leading member of the law firm of Carter & Eaton. He was induced to accept the position through the mediation of his friend, Grosvenor P. Lowrey, and when Norvin Green resigned, Eaton was elected president at the annual meeting of the stockholders on October 24, 1882.

At that meeting, Edward H. Johnson, fresh from his success in England, was elected vice-president. The English press accorded Johnson the honor of proclaiming 'There is but one Edison, and Johnson is his prophet.' That epithet designated Johnson, and I mean it honorably, for he never boasted of himself nor did he swagger with 'I's' or 'we's' about himself like others when giving an after-dinner talk which some subordinate had to write.

He had assisted Edison in his automatic telegraph experiments and represented him when the phonograph appeared; in England he introduced Edison's carbon and chalk telephones and the system of electric lighting. His English mission with the electric light was most successful. He took over the first high-resistance lamp that Englishmen had ever seen, and erected a large temporary central station in London. He stood before Parliamentary committees and was questioned by noted

EDWARD H. JOHNSON



WILLIAM H. MEADOWCROFT

scientists and witty politicians, yet never was outwitted. He brought about the English Edison Company.

Yes, Johnson was Edison's prophet, and he defended his great achievements with solemn enthusiasm; no obstacles could block his way. Edison was fortunate in having such a defender. When Johnson returned home, he soon perceived that things were not going as they should, and went into action immediately. He felt humiliated to see that Edison isolated plants had to compete with those of infringers, and he told Edison that The Edison Electric Light Company should act to protect his valuable rights. Johnson's presence was felt and the Johnsonian era began. I shall come back to Johnson later.

Eaton's secretary was a young lawyer, William H. Meadowcroft, who is affectionately remembered by all Edison pioneers. He did some work for Edison in magnetic ore milling work at Quoque, Long Island, New York, and at Labrador. He entered business later, but soon returned to Edison's employ. In 1910, Edison made him his secretary, and he remained in that position until his great chief passed away on October 18, 1931.

Meadowcroft was also a writer, but the most commendable part of his life's work was that as confidential and devoted secretary(1) to Edison for twenty-one years.

Before he and his family moved to New York City, Edison used to journey nearly every day to '65,' and as he required some clerical assistance at his new office, he transferred Charles P. Mott from Menlo Park to the New York headquarters. Mott, brother of Sam, the patent draftsman, used to be a sort of handy man at the Menlo Park office.

(1) In his life Edison had the following secretaries:

Stockton L. Griffin	Menlo Park, N. J.	1878-1880
Samuel Insull	New York, N. Y.	1881-1887
Alfred O. Tate	West Orange, N. J.	1887-1894
John F. Randolph	West Orange, N. J.	1894-1908
Harry Miller	West Orange, N. J.	1908-1910
William H. Meadowcroft	West Orange, N. J.	1910-1931

When Samuel Insull arrived March 1, 1881, Mott went elsewhere, and Insull became Edison's secretary. It was E. H. Johnson who indirectly recommended Insull, as he had been formerly employed by Edison's British agent, Colonel George E. Gouraud, in London, England.

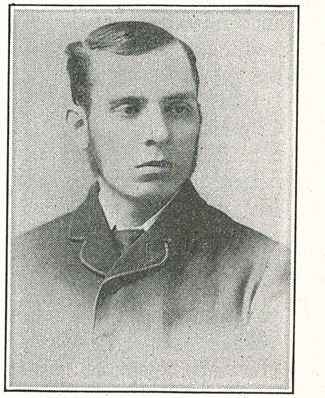
Insull was a young man of twenty-one when he landed in New York, and he soon found himself at home at '65,' in the role of private secretary. This American service was new, much different from the little office he had left in London. He soon perceived that Edison was congenial, good natured, and easygoing, especially with regard to office management, which was soon intrusted to his care. It must not be forgotten that at that period Edison was in one of the most embarrassing positions of his life. There were many things to do, and everyone looked upon the wizard for guidance.

Edison and his star assistants, Batchelor, Upton, Bergmann, and Kruesi organized and financed the erection of those first industrial monuments of a new art, without precedent. There was plenty to do at the office at '65,' and it was Insull's job to attend to it after getting the leads first from Edison, or from the marginal notes Edison was wont to jot hastily on his correspondence.

When affairs increased, Insull obtained the assistance of William E. Gilmore, a stenographer who had previously assisted Frank McGowan, stenographer of Major Eaton.

Edison did not like to attend directors' meetings, and often sent Insull, by proxy, to attend and to report to him. The circumstances in which Insull found himself provided great schooling days, and seethed with opportunities.

At '65' could be found bankers, financiers, promoters, schemers, engineers, technicians, and directors. As Insull came into contact with them, it flattered his ego and self-consciousness. Once Edison had Insull with him when he came to Menlo Park, and while



Samuel Insull, taken in 1881 by McDonnald & Sterry, Albany, New York.

waiting for some data about his meter, related a juicy anecdote of a young man who by constant practice had learned, let us say, how to pipe a certain national hymn, but his unbounded ambition led him to try a variation, and a most humiliating predicament befell him. The story had a special significance for young men who were too impetuous in starting out in life. By some of the Menlo Park 'boys,' its moral was never forgotten.

Insull was diligent and, coming into contact with so many prominent men, gradually worked himself up as business grew. Others, of course, kept a watchful eye on Edison's business as time passed; many things happened with which Edison did not agree. The eyes were those of Drexel, Morgan & Company, which organization always had at least one of its men on the board of directors of the Edison companies. It was regretted that Edison did not have a serious, mellow, and experienced business executive to take charge of his industries from the start. Bergmann had the desirable qualities, but he would never have consented to leave what he had built up, as long as he was connected with it.

That Edison recognized the value of a good businessman was exemplified by the fact that after the technical difficulties had been overcome at the Pearl Street Central Station, he looked about for a businessman to run it, and selected Charles E. Chinnock. Edison guaranteed him $10,000 if he succeeded in putting the station on a paying basis. Chinnock succeeded, and Edison paid him the money out of his *own* pocket. That first central station in the world was erected by the Edison Electric Illuminating Company of New York. It was, of course, a licensee of The Edison Electric Light Company, and was incorporated on December 17, 1880, with a capital of $1,000,000. I mention this to show the confidence that Edison's backers had in his system of domestic lighting, and may add that when some of the stockholders began to waver later on, he dug into his own private fortune to restore their confidence.

Then came his invention of the three-wire system, the patent application of which was signed on November 20, 1882. That system of current distribution was destined to clear the way for the future, for it gave the Edison system a brighter lease on life. With it, a sixty-two per cent copper investment was saved. Edison had to make a heroic effort to demonstrate its possibilities, and had to apply it in practice

himself and to observe what antics, if any, might develop.

He also perceived that a new order of business procedure had to be inaugurated to give the central-station industry an impetus; his idea was to solicit, not States' rights, but local interests. More than this, he determined to erect small stations, to operate them, and to instruct all interested. Not until one operated well did he hand it over to the local company. Edison financed this undertaking himself, under the name of The Thomas A. Edison Construction Department. On July 4, 1883, this new system was put into operation for the first time at Sunbury, Pennsylvania. Bare copper overhead conductors were used. William S. Andrews and Frank J. Sprague assisted Edison in the installation work, and after Edison had erected several such small central stations in the coal belt and elsewhere, he considered his work had accomplished its object. The department was merged into the Edison company for isolated lighting in the latter part of 1884, having been in existence a little less than two years.

Edward H. Johnson was then president and general manager of the Edison company for isolated lighting. While sojourning in Sunbury, Edison compiled rules for the station attendants, which I hope to give later. The good work he did in showing and proving the practical adaptation of his three-wire system gave a sudden impetus to central-station erection.

Insull, who was still attending to the Edison office at '65,' placed Alfred O. Tate in the Edison construction department. Tate was an able young Canadian who had business experience, and relieved Insull of part of the work.

As described by a distinguished assistant of Edison in those days,(2) 'Tate was an energetic pusher with considerable *bull*, who seemed to supplant Insull in some respects with Edison.' In fact, Tate was appointed private secretary in the autumn of 1887 when Edison's power of attorney was transferred from Insull to Tate, who held the same for eleven years.

Tate had railroad experience and was a good accountant; Insull was fortunate to get a man of such ability, versed in technical matters. His assignment to the Edison construc-

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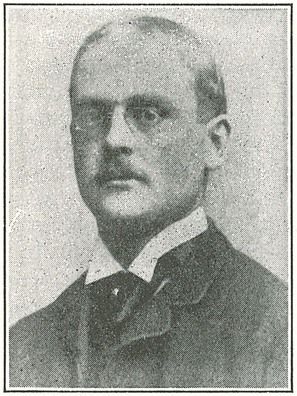
(2) In 1938, Tate published a book under the title of *Edison's Open Door*. It contains many interesting facts about Edison. He delineates Insull's personal character, and states that Insull's 'great ambition was to acquire wealth . . . He loved power and gloried in the exercise of authority.'



ALFRED O. TATE

tion department places Tate's name on the pioneer roll of those who participated in the last efforts made by Edison to place the central-station industry on a sound, successful footing. With that work, Edison established the three-wire system as an accomplished commercial fact.

Why Insull, years later, in his book on *Central Station Electric Service*, should label the Edison construction department as the 'destruction department' has been a puzzle to the old-timers, most of whom recognized the great and successful pioneering service Edison had rendered to the art. Insull admitted that '*it served its purpose; never made any money*.' Edison's purpose was to show the value and economy of the three-wire system; he had no intention of making money out of it. His object was to teach and to demonstrate it to others, and to restore the confidence already waning on account of the excessive copper investment of the two-wire system. Thus Edison's work was not in vain.

To insure success, Edison now resorted to a thing he had never done before. He set about in a friendly way to purge the board of The Edison Electric Light Company of a few recalcitrant members; Johnson was behind him in this move. It was known that in the parent company there had existed for some time two parties in the management of its affairs —one slow, the other active and energetic—willing to spend money for the sake of making it.

In order to get rid of the unwillings and have only a board of the willings, Edison appealed to the stockholders for proxies, and won. When Major Eaton resigned, he and Eugene H. Lewis started the law firm of Eaton & Lewis. The latter married a lady by the name of Miss Amy Busby. The marriage took place March 19, 1897. I well remember Eugene H. Lewis when he was the tutor of G. P. Lowrey's sons. I have heard Mr. Lowrey praise him for his tactful

and courteous manners. At the same time he had a high opinion of his abilities as a rising young lawyer. Edison had known Lewis for nearly twenty-five years, and the latter was one of his trusted advisers. Lewis gained a high reputation as a corporation lawyer, guiding the legal affairs of the various Edison companies and those of the General Electric Company when it was formed. He died in 1907.

The following are the names of the men who were elected in October 1884, on the new board of directors in the parent company, as well as those in the isolated company for lighting plants:—

The Edison Electric Light Company

Eugene Crowell, *President*	Edward H. Johnson, *Vice-president*	F. S. Hastings, *Secretary and Treasurer*

Directors

Dr. E. Crowell	C. H. Coster	A. Foster Higgins
E. H. Johnson	Erastus Wiman	R. L. Cutting, Jr.
T. A. Edison	E. D. Adams	Francis R. Upton
J. Hood Wright	Spencer Trask	Charles Batchelor
	F. S. Hastings	

The Edison company for isolated lighting—licensed by The Edison Electric Light Company for the sale of isolated plants and the formation of central station companies:

Edward H. Johnson, *President and General Manager*	F. S. Hastings, *Secretary and Treasurer*
J. Hutchinson, *Manager*	J. H. Vail, *General Superintendent*

Directors

E. H. Johnson	C. H. Coster	F. S. Smithers
Dr. E. Crowell	Charles Batchelor	Thomas C. Buck
T. A. Edison	Francis R. Upton	Anthony J. Thomas
J. Hood Wright	Spencer Trask	

Among these names we see Edison's and three of his star assistants; the others were all pro-Edison at that time. Batchelor was general manager of the Edison Machine Works, and Upton was manager of the lamp works in which Johnson was also interested from the start. It may be mentioned, too, that Johnson was also virtually president of the parent company. Dr. Crowell was a congenial, wealthy old gentleman who held a large block of the company's stock, and thus was given the honor of being president. It will also be noticed

that Villard's[3] name is not in the list. He and some others were not re-elected, but he did not give up what he was after. Edison still had work to finish before Villard was to be permitted to act.

As I have said, Edison's persistence in this last roundup set things going. It also marked the time when he was considering other objectives, for he regarded his principal work soon finished. He, of course, had his interests in his personal manufacturing concerns, and controlled them. He had his star assistants, Batchelor, Kruesi, Upton, and Bergmann, managing his works, while Insull, his private secretary, was taking care of the office in connection with the general business.

(3) Henry Hilgard was a German born in Speyer, Pfalz, Bavaria, and when he came to America, he changed his name to Villard. He was a bright and enterprising journalist, worked for the *New Yorker Staats Zeitung*, was a Civil War correspondent for another newspaper and again a war correspondent in the Austro-Prussian conflict, and then turned his attention to enterprises and became a promoter. He acquired control of the Northern Pacific Railroad and became its president; later, the railroad came into the hands of a receiver. He interested himself in the Edison system and had it installed on the S. S. *Columbia*.

See Vol. II, *Menlo Park Reminiscences*, pp. 556, 559, 592, and 767.

XCIII. Edison and Villard

(THE GENERAL ELECTRIC COMPANY)

EDISON'S faithful consort, Mrs. Mary Stilwell Edison, who had been with him during the time he gave his most priceless gifts to mankind and had seen him rise to fame, passed away on August 9, 1884. Toward the end of 1885, Edison longed for a home again. On February 24, 1886, the Edison-Miller[1] marriage took place in Akron, Ohio.

A new life was thus opened; new obligations and duties presented themselves. Edison settled with his bride at 'Glenmount,' Llewllyn Park, in West Orange, New Jersey. He decided to build a modern laboratory near-by, and to take up new research work again, as well as to start a group of new industries there.

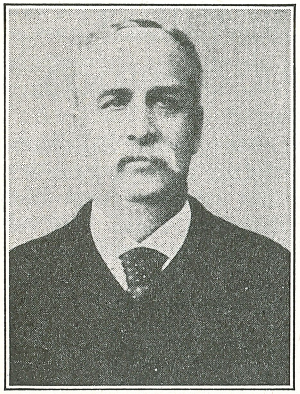
Thus we see, taking it all as it came to pass, a new and different Edison was emerging, gradually edging out of the electric lighting business and slowly reducing or liquidating his interests in the industries that he had brought into being.

He also visioned the changes that were taking place in the electric light business. Pirates were on all sides. Lawsuits would soon follow, requiring great financial sacrifices.

Again, Edison knew that he was ultraconservative as to what he had created, that if a progressive invention or adjunct appeared, he would hesitate to employ or even to recommend it, although it might enhance his system.

He recognized that he and his friends were only licensed to make his lamps, generators, and accessories; that they had invested their private fortunes in erecting the different works, but were really dependent on the parent company. He had fulfilled his promises, and he considered himself free to start again on new work. At last he saw the coming realization of his desires. He, of course, kept his eye on his manufacturing concerns, and was always ready to give advice when necessary. When his presence was demanded, for the sake of prestige, he would willingly show up. Yet, 1886

(1) Miss Mina Miller was one of the most beautiful and fascinating belles of her day. Her father, Lewis Miller, was a distinguished inventor and president of the Chatauqua Movement in Jamestown, New York. This marriage was blessed, as was his first, by three children: Charles Edison, Theodore M. Edison, and Madeleine Edison.



HENRY VILLARD

brought the dawn of a new life's course to him.

It was clear that the future sequence of his business affairs, with regard to industries, was already predetermined; he knew what was going to take place. Before that would happen, a good showing had to be made. At the same time, other matters had to be slowly initiated by outsiders, in the final act. Months before time the secret leaked out, and I mention this to show that certain incriminations or insinuations that came up later were without foundation.

Edison's personal industries might be described at the time as follows:

The Menlo Park Edison Lamp Works. Started early in the fall of 1880. On April 1, 1882, the factory was moved from Menlo Park to Harrison and operations started again on June 1, 1882. In 1884, the Edison Lamp Company was organized; it was incorporated with a capital stock of $250,000, and later sold for $1,085,000. Batchelor was the first manager; he was succeeded by Upton. Like all of Edison's other manufacturing concerns, the lamp factory was merged into the Edison General Electric Company in 1889.

Bergmann & Company. Sigmund Bergmann had commercialized Edison's early inventions, like the phonograph and loud-speaking, chalk-receiving telephone. He also made the Edison sockets and switches in his shop at 108-114 Wooster Street, New York City. In the early part of 1881, the firm of Bergmann & Company was formed, the partners being Bergmann, Edison, and Johnson. In 1882, the firm moved to a larger building at Seventeenth Street and Avenue B, New York City. Later, an annex was rented at Twenty-seventh Street and First Avenue. In 1889, it was taken over by the Edison General Electric Company.

The Edison Electrical Tube Company. Organized by Edison in January 1881 with a capital of $25,000. Kruesi was manager. At first the shop was at 65 Washington Street, New York City. In 1883, it was moved to 18-24 Bridge

Street, Brooklyn. In 1886, it was merged with the Edison Machine Works, and taken over by the Edison General Electric Company in 1889.

The Edison Machine Works. Organized by Edison in March 1881, at 104 Goerck Street, New York City. He was assisted by Charles L. Clarke and Charles Dean. In 1884, it was incorporated with a capital of $200,000. Late in 1886, it was moved to Schenectady, New York, and in 1889, merged into the Edison General Electric Company.

The Canadian Edison Manufacturing Company. Organized to manufacture in Canada Edison's generators and other parts of the system (except the lamps). The shops were located first in Sherbrooke, near Quebec. Later, they moved to Peterborough, Ontario. The company was merged with the Edison General Electric Company in 1889.

The Edison Shafting Company. Organized in July 1884, with a capital of $10,000, to manufacture shafting, hangers, and pulleys. Its office was on Dey Street, New York City. It was merged into the Edison Machine Works in 1886, and into the Edison General Electric Company in 1889.

The Thomas A. Edison Construction Company. Already described in detail. As has been pointed out, it was taken over by the Edison company for isolated lighting in 1884.

In July 1886, various Edison industries were unified; that is, the Edison Machine Works, the Edison Lamp Works, and Bergmann & Company were incorporated under the name of the Edison United Manufacturing Company. It took over the entire building at '65' for offices and showrooms. The unified direction of the concerns was intrusted to Joseph Hutchinson, general manager. The new firm also acquired the right to do all the installation work for the Edison company for isolated lighting. It must not be forgotten that the last-named firm, like The Edison Electric Light Company (the parent company), was not a part of Edison's industries.

Thus, when the Edison United Manufacturing Company took over the installation work of the Edison company for isolated lighting, including central stations, it had practically everything in its hands—that is, in manufacturing and installing the Edison system. After the parent company and the isolated company were merged on December 31, 1886, there remained only the Edison Electric Light Company with its patent rights on one side and the Edison industries

on the other. When the Edison United Manufacturing Company took over the whole building at 65 Fifth Avenue in 1886, the Edison Electric Light Company, that had conveyed concessions and had started many sub-Edison electric light companies in different parts of the country, moved its executive offices downtown to financial quarters at 44 Wall Street.

The Edison United Manufacturing Company ceased business in October 1889, and was succeeded by the United Edison Manufacturing Company, as the active company handling the business was then known.

On April 26, 1889, a circular was sent from the Wall Street office to the stockholders of the Edison Electric Light Company, informing them of the scheme to acquire their stock and the three Edison works—the Edison Machine Works, the Edison Lamp Works, and Bergmann & Company, and perhaps also the Sprague Electric Railway and Motor Company. In that circular, which was signed by James B. Williams, president, it also stated that the German General Electric Company and Siemens and Halske, both of Berlin, Germany, were included in the syndicate that Villard had organized.

Edison tells how Villard was in a stupor, caused by his plight when he lost everything in connection with The Northern Pacific disasters. Trying to cheer Villard up, Edison told him how rapidly the development of the electric light system was progressing and how it would help him to retrieve his fortune. Villard made his great rally, made money, and got control again of The Northern Pacific.(2)

Those who followed events during the years before 1889 recognized that all who were interested were in harmony with what had taken place. There was no one who was a greater guardian of Edison and his financial interests, as well as the Edison system, than J. P. Morgan and Drexel, Morgan & Company. All were in accord with what Villard was doing, as is proved by the fact that Edison always entertained a high respect for him and his ability, and considered him a 'square shooter.'

'Villard,' said Edison, 'was a very aggressive man with big ideas.' Talking of the Schenectady works years later, Edison remarked, 'These works were owned by me and my

(2) Dyer & Martin—*Edison: His Life and Inventions.*

assistants until sold to the Edison General Electric Company.' Edison also said, 'When Villard and his syndicate offered to buy us out, we concluded it was better to be sure than be sorry; so we sold out for a large sum.'

In 1892, when Villard and J. P. Morgan formed the great combination under the name of the General Electric Company, it constituted a marked progressive event in the history of heavy-current engineering. I know of a certainty that the consolidation of 1892 was mainly the work of J. P. Morgan, Drexel, Morgan & Company, and C. H. Coster. Villard was only the 'arranger,' and no one else had much to say. That new company was destined to preserve Edison's great achievements and at the same time root out the ultraconservative attitude so handicapping to the old Edison company. With its liberal views, the General Electric Company has done more for the perpetuation of Edison's ideals than would have been possible, had not Villard appeared on the horizon.

Villard sought new fields. The valuable Edisonian assets, together with the further needs of nearly 200 Edison central stations, plants, and future prospects, came under the healthy, vigorous management of Charles A. Coffin, first president of the General Electric Company. Yes, new blood, liberal ideas, ability, comprehensive vision, and experience mellowed by years of hard work, gave Coffin that executive preponderance that has led Edison's great work on successfully.

When the General Electric Company was formed, there was an apparent flutter of surprise, accompanied by recrimination and suspicion of double crossing. The statements made by Edison in the New York *Times* of February 21, 1892, and what I have so far stated, absolve anyone upon whom a slur or aspersion fell. Why an argument came up is difficult to say, for everything progressed according to the schedule arranged a long time before. Here is what Edison said:

'At the beginning of the manufacture of electrical apparatus, I owned the little shops and was proprietor of the business as far as my own patents were concerned. The business grew and *I could not attend to it*. I sold out most of my interest at good and satisfactory figures, and *for three years*, I have not owned more than ten per cent of the stock of the Edison General Electric Company.'

In 1886, when the strike broke out in the Edison Machine Works in Goerck Street, Edison, Batchelor, and Kruesi

conferred and decided to move out-of-town. An opportunity presented itself to acquire buildings that once had been used by the McQueen locomotive works in Schenectady, New York. Late in 1886 ,the Edison Machine shop on Goerck Street, New York City, and the one on Bridge Street, Brooklyn, were slowly being moved to Schenectady. It was some months before the moving was completed.

Batchelor, general manager, and Kruesi, assistant manager, were straining every effort to get the Schenectady works in order, and to commence production. Occasionally Edison would visit the works, but his confidence was placed in his two star assistants. His place was at West Orange, New Jersey, with his young wife; his mind was on his new work in the new laboratory there.

Insull was sent to Schenectady as secretary and treasurer, while Tate became Edison's personal secretary. When Batchelor left Schenectady in the latter part of 1887 to join Edison again at West Orange, Insull received the title of treasurer and general manager. Edison held the title of president; Batchelor, vice-president; Kruesi, assistant general manager; and Hutchinson, secretary. Such was the general aspect of the situation as it appeared to the outside world; yet, behind scenes, the stage was being set for the play that was yet to follow.

The Edison Machine Works had about 500 to 600 employes at the time. Business was good and on the up trend. When Batchelor left Schenectady, there were more than 200 Edison central stations operating, plus a large number of isolated plants; and all consumed the products that were manufactured by the Edison industries, either in Schenectady, New York; Harrison, New Jersey; or Avenue B in New York City. The great impresarios who silently headed and directed the settings for the stage were Henry Villard and C. H. Coster of Drexel, Morgan & Company. There can be no doubt that those who had a personal interest were well aware of and anxious for the final act. Those who took part did only what had been scheduled for them to do.

I have already described events at 65 Fifth Avenue in 1886, and noted the changes that had been made. In 1888, the public became acquainted with a most interesting illustrated supplementary article in the *Electrical World*,(3) showing the progress made by Batchelor and Kruesi at the Edison Schenectady Machine Works. In the same journal we find, in December 1888, that rumors were spreading about a combination of all the Edison concerns.

(3) *Electrical World*—August 25, 1888.

On April 26, 1889, came the circular from 44 Wall Street, stating that a corporation called the Edison General Electric Company with a capital of $12,000,000 had been formed. Henry Villard was its president; J. H. Herrick, vice-president; Samuel Insull, second vice-president and general manager; and F. S. Hastings, treasurer. Thus, we see that by 1889 Villard had skillfully managed to unite all Edison-named concerns into one unit. Edison was free and, as he said, he did not take much interest in the business end.

Edison was, of course, always ready to give advice and to add to the prestige of the company by visiting the Schenectady works. He was delighted to attend the conventions of the Association of Edison Illuminating Companies; he enjoyed occasions where the presence of his great personality gave luster and publicity.

Insull, after being with Edison for about eight years, now had a new boss, under whose aggressive leadership he acquired valuable experience for his future work.

In behalf of Insull, it should be said that while connected directly with Edison, his management of his duties was always satisfactory to his chief. I must further add that certain whisperings in those days were without foundation. Insull did what he was told. The acts of Villard and others were no surprise to many and only resulted in valuable rescue service to the Edisonian cause, as well as to Edison and to the industry through its successor, the General Electric Company.

Villard was not in the game for his health. He and the bankers wanted a short, quick turnover and, as usual, a profit. Villard himself said that by 1892 the capital of the Edison General Electric Company was increased to $15,000,000. He said, 'The German friends made a handsome profit by the sale of their holdings before his retirement from the presidency . . .'

There was only one thing that many intimate friends of Edison, and no doubt Edison himself, regretted. That was the change in the title of the company—considering the gigantic assets that Edison's inventions brought into the merger.

XCIV. Edison and Johnson

(PIONEERS OF 65 FIFTH AVENUE)

GOING back again to 1881, I have mentioned William E. Gilmore, who entered the service at '65' to assist Frank McGowan, performing clerical work for General Manager S. B. Eaton. Gilmore was transferred to Edison's office later and then to the Edison Machine Works. When the latter moved to Schenectady in 1886, Gilmore followed. In 1889, he assisted Kruesi in his office. When the General Electric Company was formed in 1892, he left to become manager of the National Phonograph Works in West Orange, New Jersey.

McGowan, after his service as stenographer, in 1887 accepted a commission to search South America for better bamboo or vegetable matter for making lamp filaments.

Charles F. Harrington was the caretaker of '65.' He was a gentleman of nice appearance, and it was said that he was often mistaken for the president of the company. At '65' he acted the part of usher and reception clerk. A magnificent billiard player and all-around sport, he became a special crony of E. H. Johnson. Harrington joined McGowan in 1887 in South America, but their work brought no practical results.

'Sixty-five' had a bright office boy who was a sort of help to Harrington. His name was Robert T. Lozier. Later, he was transferred to the Edison Machine Works and succeeded as an electrical engineer and businessman. When the Edison Pioneers was organized on January 24, 1918, he was unanimously elected its first secretary. His services were many in the Edison cause, for Lozier was one of those rare persons who possessed the virtues of a gentleman. His integrity and honesty of purpose endeared him to all. It was with extreme regret that his numerous friends heard the sad news of his passing in 1921.

Miss Selden was one of the first lady typists and office helpers employed by The Edison Electric Light Company. Lemuel W. Serrell was Edison's patent attorney for about ten years, from 1870 to 1880. Serrell handled Edison's patents during that period, including those of the telegraph, tele-

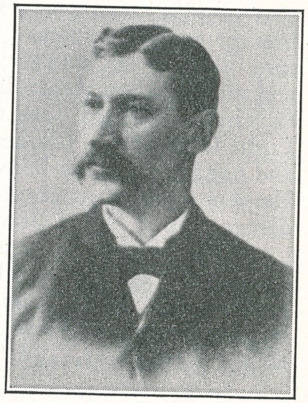
phone, electric pen, phonograph, and the ones pertaining to Edison's first work in electric lighting.

Dyer & Wilber followed, beginning with 1880, and they and their successors—always a Dyer—took care of the numerous patents in electric lighting and other subjects till after 1914. I may say that the Dyer family contributed eminently to the Edisonian cause. The head of the family was Colonel George W. Dyer, whose rooms were on the third floor at '65.' His son, Richard N. Dyer, assisted his father and later succeeded him as Edison's patent attorney. The firms with which Richard N. Dyer was associated were Dyer and Seeley; Dyer and Driscoll; and Dyer, Edmonds, and Dyer. In 1898, another son, Frank L. Dyer, succeeded as patent attorney and continued until 1914. Then the firm of Dyer and Holden was formed, and this firm represented Edison for several years.

At the time of Edison's death, the solicitor in charge of the Edison work was Henry Lanaham, who was once associated with Frank L. Dyer during the Holden regime.

There was also Philip S. Dyer, who was secretary and had charge of the office affairs of the first lamp factory back at Menlo Park, in 1880.

I must not forget another personality often seen at '65.' He was Charles S. Bradley, a man of fine scientific attainments, who had entered the service in 1881 in connection with the Edison Illuminating Company. Bradley, as electrician, had charge of the Edison underground conductors, and in the early part of 1882, Schuyler S. Wheeler was placed under him as an assistant. Bradley made a voltmeter based on the Wheatstone principle that was used at the Pearl Street station for obtaining the pressure at the feeders. Later, this principle was improved by John W. Howell, lamp engineer of the Edison Lamp Works. Bradley left in 1883 to start a laboratory in New York City; he made many inventions in the different fields of electricity. Wheeler left the service in 1886 to become an electric-motor



CHARLES S. BRADLEY

manufacturer with Charles C. Curtis and Francis B. Crocker under the name C. & C. Electric Motor Company. In 1888, the firm was changed to the Crocker-Wheeler Company.

Then there was Joseph Casho who was steam engineer and first superintendent at the Pearl Street Central Station. He left the Edison service in the spring of 1883.

Casho was followed by Charles E. Chinnock who has already been mentioned. Later, Chinnock became the general superintendent of the Edison Electric Illuminating Company of New York and vice-president of the Edison United Manufacturing Company. He was very active in securing orders for plants for his company, and rendered conspicuous services in the introduction of the Edison system.

There was also John William Schroeder who commenced in the Menlo Park Lamp Works and after a few months joined the Edison company for isolated lighting, where he soon rose to become one of the successful agents in negotiating the sales of Edison plants. In 1885, he started his private agency in procuring orders for the Edison company. He was also connected at one time with Bergmann, and being an excellent accountant, was assistant to the receiver of the Thomson-Houston Electric Light Company of New York City.

William F. Brewster, a Civil War veteran, once told me he had been a boyhood friend of Edison's at Port Huron where they used to play with the 'gang' around the grounds of Fort Gratiot near-by. He was induced by Edison to join the staff of The Edison Electric Light Company in the early part of 1881, acting as a special foreign agent for organizing foreign central stations. Clarke relates that Brewster told him that he enlisted in the Civil War as a drummer boy and that his honorable discharge was signed by our Colonel Calvin C. Goddard, later first secretary of The Edison Electric Light Company. Clarke added that Brewster was a 'pusher and nagger.' I knew Brewster's temperament from experience. He was a sort of inventor, too, and it was said that he was a descendant of Elder Brewster of *Mayflower* fame.

Other special business agents at that early period were Charles A. Benton(1) who joined the Edison staff in 1881; Frederick D. Potter came in 1882. Benton, known to the boys as the 'major,' was a dispatch rider for General Sheridan in the Civil War, and he was regarded as an expert connoisseur of horseflesh. That made him a special friend of E. H. Johnson, when the latter bought an elegant chateau in Greenwich, Connecticut, in 1887. Clarke told me that the place had belonged to Carnegie. Johnson had sold his interest in the Sprague Company for $400,000. He then had bought the chateau and at once proceeded to squander the money by 'improving' it to his extravagant notions. I visited him there in the early 1890's. It was *fine, very fine*—with all sorts of gimcracks. The 'major' was called upon to stock Johnson's stables with fine riding and carriage horses.

(1) Charles Abner Benton passed away on March 15, 1939.

A fine, jovial, and agreeable gentleman, Major Benton was beloved by all who knew him. With meritorious devotion he served the Edison cause in those early days, and was eminently successful in procuring large orders for Edison plants. Frederick D. Potter, too, was prominent in his efforts to further the cause, and the services that he rendered were appreciated by his superiors.

The chief executives of The Edison Electric Light Company were Norvin Green, president, followed by Major Eaton. Egisto P. Fabbri was treasurer and Colonel Goddard was secretary. Assistant to the above-named gentlemen was Frank S. Hastings, who, in 1885, advanced to the secretary- and treasurership, not only of the parent company, but also of the isolated lighting company.

Another assistant was Joseph Hutchinson, who, in 1885, became the manager of the isolated lighting company, and in 1886, manager of the Edison United Manufacturing Company. Among the directors and stockholders of the company and other influential men of that period who often put in their appearance at '65' were J. Pierpont Morgan, Henry Villard, Tracy R. Edson, Nathan G. Miller, James H. Banker, Edward D. Adams, Robert L. Cutting, James O. Green, J. Hood Wright, R. M. Galloway, C. H. Coster, G. P. Lowrey, and J. F. Navarro.

Coming back now to Johnson, let me quote what William J. Hammer, our old Menlo Park colleague, said: 'He had a genius for organization, and his energy, optimism, and forcefulness did much to make the various companies successful and to put backbone into the directors.'

Johnson altered the 'Promoter's Contract' blank forms drafted by the parent Edison company in 1882 to ones far more liberal and acceptable to promoters. Instead of giving promoters large territorial rights for the system, Johnson

introduced the policy of giving only local companies Edison franchises. The following will give an idea of the policy that gave the impetus in pushing the erection of central stations; it was taken from an early Edison pamphlet:

ORGANIZATION OF LOCAL COMPANIES

'The Edison company show their entire confidence in the ability of local organizations to earn dividends by terms upon which they grant the local company the franchise to use their system and all apparatus pertaining thereto. Having at the outset unbounded confidence in the assurance of Mr. Edison that his system in its entirety was based upon sound theoretical and commercial principles, the Edison company adopted the policy which experience has since proved correct, and which it has therefore no reason to regret and certainly no intention of altering, of taking as a full consideration for all franchises sold under these patents, a share in the business created thereunder by the invested capital of the parties purchasing the rights.

'The fact that the parent company grants a license to the local company from which it can receive nothing of value unless that company is a commercial success, carries with it that element of partnership which insures for all time the watchful guardianship of the parent company, guaranteeing to the local company the best advice, improvements, instruction, and guidance that is in its power to give. The Edison company sells only its franchise to local companies; all machinery apparatus and supplies are purchased of the licensed manufacturers at factory prices. The Edison company derives no profit from such sales. It gets compensation for the rights it grants only from a share in the net earnings of the enterprise created under these rights; hence, unless it is believed that there will be net earnings, a license will not be granted. This policy protects alike the parent company and the licensee. It makes their interest identical and it assures the local company that everything that the parent company can do to increase their dividends will be done.

'This identity of interest has led the Edison company to collect and tabulate all kinds of data influencing the economy of running all existing stations; data regarding the construction, maintenance, and operation of the steam plant; data regarding the arrangement, maintenance, and operation of the electrical plant; data regarding the number and quality of employes necessary to operate a plant successfully; data regarding the best methods of selling light and power, of keeping all records and accounts; in fact, all information which can benefit a new station has been collected and tabulated, and each new station has the benefit of the combined experience of all the preceding ones.

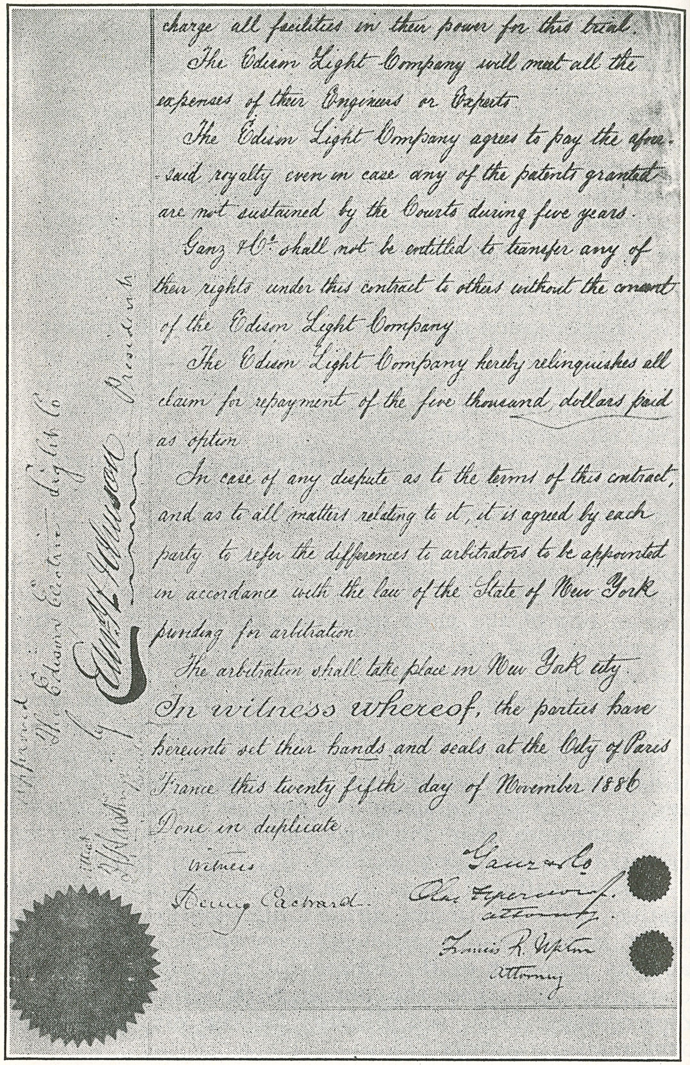
'Each station sends a monthly report to the parent company on all these points affecting its economy of running, and by a comparison with the records, any defects in its methods of operation are pointed out and the remedies suggested.

'Inquiry will show that, like any other business, everything depends upon its management. A good, energetic manager is essential to success.'

Johnson was president, vice-president, or director in many companies; yet, he created another position which today is one of the most important in all great industries and utilities, and that is, Johnson was Edison's public relations manager. His tireless activities have left a lasting effect in Edisonian history. His earnest persuasiveness brought the parent company into action against the infringers of the Edison system. Some old-timers no doubt remember his Red Book, *A Warning From The Edison Electric Light Company*, in which he denounced the business morals of electric light companies that infringed the Edison lamp or had purchased the infringing products of a foreign pirate.

How he walloped them! The repercussion that followed, together with his tirades against high-tension alternating current, created serious arguments everywhere. On the other hand, as president of the Edison Electric Light Company, he approved and signed the contract with Ganz and Company (Zipernowsky, Deri, and Blathy) for the use of the first commercial transformer.(2)

(2) See Vol. II, *Menlo Park Reminiscences.*



charge all facilities in their power for this trial.

The Edison Light Company will meet all the expenses of their Engineers or Experts

The Edison Light Company agrees to pay the aforesaid royalty even in case any of the patents granted are not sustained by the Courts during five years.

Ganz & Co. shall not be entitled to transfer any of their rights under this contract to others without the consent of the Edison Light Company

The Edison Light Company hereby relinquishes all claim for repayment of the five thousand dollars paid as option

In case of any dispute as to the terms of this contract, and as to all matters relating to it, it is agreed by each party to refer the differences to arbitrators to be appointed in accordance with the law of the State of New York providing for arbitration

The arbitration shall take place in New York city.

In witness whereof, the parties have hereunto set their hands and seals at the City of Paris France this twenty fifth day of November 1886

Done in duplicate

Witness

Ganz & Co

Francis R. Upton
Attorney

Last page in the contract between The Edison Electric Light Company and Ganz and Company of Budapest, Hungary. Johnson's signature as president.

Then, again, he backed Frank J. Sprague and his motor, organizing the Sprague Electric Railway and Motor Company and drew them into the sphere of the Edison interests, in direct opposition to Edison's wishes. Johnson, of course, was the president of the Sprague Company, and Hammer once told me that Johnson sold his interests in the Edison Lamp Works when he started it.

Johnson was also president of the Boston Edison Illuminating Company in 1885. He induced the parent Edison company, the Edison industries, and J. P. Morgan to back up financially the proposition in Boston. His activities were many, and his presence during that period of pioneer introduction and exploitation of Edison's system was salutary.

Those were hard, rough days for Edison, and numerous were the encounters and obstacles met with during those early 80's when New York City was under the rule of the Tweed Ring. For some time after 1880, Edison had to work out personally the detail and special features comprising the practical side of the generation of current in a central station and the conducting of that current through an underground system to customers, and there make it manageable for any purpose.

We must not forget that Edison gave the world a *complete* system of domestic lighting that comprised everything from the lamp to the last thing in the central station. As nothing like it had been done before, Edison had to design and to manufacture the necessary machinery and accessories which a complete system required. That feat was as great as all the work he had done in creating the system and lamp at Menlo Park. Yet, people were getting impatient with what seemed the tardiness for the final showdown of his promised system of current distribution for all purposes. When we consider the short time that elapsed between the birth of the practical lamp and the starting of the Pearl Street Central Station—that is, between October 21, 1879 and September 4, 1882; hardly thirty-five months—we must agree that Edison made a tremendous accomplishment, now proved to have been one of the greatest civilizing factors of the century.

It was during that time, as well as a few years afterward, that Johnson gave his best efforts to temper the conditions of affairs in all directions and to vindicate with his flaring personality the rights of Edison. He did it well, and his efforts opened the path that led the first and only system of

domestic lighting to permanent success. I know that many were not so enthused about Johnson, but if he had not had the backing of Edison from the first at '65,' he would not have attained the position of power later. They, of course, had disagreements as in all business, but Edison's wishes were generally 'law.' While with the Edison interests, success had smiled on Johnson, and as liberal as he generally was, he was too liberal with himself. After a few years his success in other lines dwindled down to nil. 'Sad!' said Clarke. 'His personal extravagance and certain habits used to worry Edison greatly and he would be sorry. You probably saw him after he was a wreck of his early self. I guess Bergmann or Insull was his *good angel* after his misfortune. Insull was that to Mrs. Johnson.'

Edison and his success lived on, and his great work has fulfilled the prophecy of Oscar Wilde who said:

'The fact is that civilization requires slaves. The Greeks were quite right there. Unless there are slaves to do the ugly, horrible, uninteresting work, culture and contemplation become impossible. Human slavery is wrong, insecure, and demoralizing. On mechanical slavery, on the slavery of the machine, the future of the world depends.'

The Edison Machine Works located at 104 Goerck Street, New York City

XCV. The Works on Goerck Street

IT WAS at John Roach's large shipyard(1) at Chester, Pennsylvania, that the S. S. *Columbia* had been built in 1880, as I have related in Volume II of my Reminiscences.(2) When the veteran shipbuilder heard that an Edison plant was to be installed in the *Columbia*, he said that they ought to try out the newfangled light on land first. He doubted whether the underwriters would pass on the plant.

Villard and Edison got in contact with Roach to talk over the matter. On this occasion, Edison mentioned that he must soon begin to think about manufacturing his heavy machinery.

(1) John Roach was born at Mitchelstown, County Cork, Ireland, in 1815. He emigrated to this country and landed in New York City when he was sixteen. The progress that this young Irish lad made reads like a romance, for he became the master shipbuilder of this country. Noted for his integrity and self-reliance, he had all the qualities of those brave men who built this country through their genius and industry. Ireland gave us many of her meritorious sons.

(2) Chapter LXIII, p. 557.

'Where are you going to build your dynamos, as they call your electric machines?' inquired Roach.

'I don't know yet,' replied Edison.

'Well,' replied Roach, 'perhaps my old works, the Aetna Iron Works on Goerck Street in New York, will suit you. You know,' he added, 'the works still has the steam engine and boilers, many heavy tools and large lathes, shafting, pulleys, and so on.'

'I will look your place over and take a couple of my master mechanics with me,' replied Edison.

So it happened that in 1881, Edison, Batchelor, and Dean inspected the place, found it acceptable for the purpose, and in the early part of March the works was taken over from Roach and christened the 'Edison Machine Works.' Here Edison founded the great industry of heavy-current engineering which, along with his lamp works and Bergmann & Company (where the accessories were made), gave the world the impetus to follow his lead. He laid down the basic fundamentals that opened vast unchartered fields. From the new art he created, bright men have ever since devoted their energies to improve, to develop, and to expand the tenets so realistically expounded by the great master.

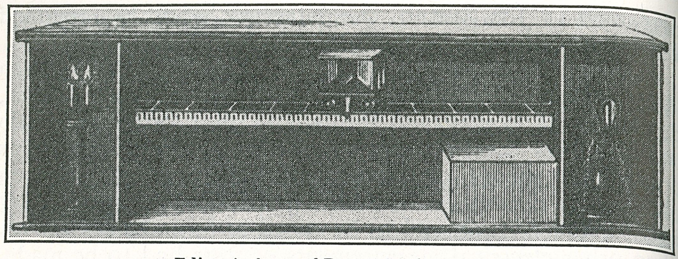
The legitimate successor of the Edison Machine Works and the other Edison industries of that period was the General Electric Company. The advances which they have made are bewildering; today those great works lead the world. Hardly a major industry exists that is not either directly or indirectly affiliated with what Edison has done. Back in 1878, when Edison had started his research in Menlo Park, he had predicted that in the future men would build great dams, and from the water power thus obtained, electricity would be transported to cities and elsewhere. Today, when we see those great hydroelectric plants in all parts of the world, we are filled with wonder.

The Edison Machine Works was situated on the east side at 104 Goerck Street, where it had a frontage of more than 200 feet and extended in the rear in an 'L' fashion to Mangin Street. A one-horse streetcar passed the works running north and turned into Houston Street, while the return car passed through Mangin Street, running south into Grand Street. The district was a tough one. Next to Mangin was the ill-famed Tompkins Street facing the East River. Thus it was not surprising that Edison was frequently accompanied by Jim Russell, the detective, when he remained at his machine works late at night.

I have already related how disillusioned I was when Edison sent me a letter to pack up all our testing instruments, the standard batteries, and the Bunsen photometer at Menlo Park and have them sent over to Goerck Street where I was to install a testing department and take charge. Edison told me later that when the building of his dynamo machinery began, every dynamo had to be tested and results registered. When other electrical measurements or tests had to be made, we and The Edison Electric Light Company could have them officially conducted in this new testing department. This testing laboratory was the first one erected. Several years elapsed before colleges even considered it advisable to start an electrical section.

The testing room in the Edison Machine Works was about seventy feet from the entrance and consisted of a large hall-like space, the roof of which was supported by a rafter construction. In the rear we partitioned off a darkroom for the

The Edison testing table as it has been restored in the Edison laboratory in Greenfield Village, Dearborn, Michigan.



Edison's form of Bunsen's photometer.

Bunsen photometer and another room for the Thomson galvanometers, Wheatstone bridges, and so on. As in Menlo Park, we built brick piers deep into the earth and rested the testing table on them. The cut on the previous page gives a true picture of our testing table as it was in Menlo Park, later in the Goerck Street works, and as it now rests in the Menlo Park laboratory in Greenfield Village. The instruments are all originals, and the brick piers were transported from the ruins of Menlo Park to Dearborn. The picture shows the Wheatstone bridges—one, the regular pattern for measuring high resistances, and the other, the sliding form to measure low resistances.

Toward the window we see the Thomson low-reflecting galvanometer; the high-resistance one is in the wooden hood and cannot be seen. On the testing table are an astatic galvanometer, silver and copper deposition cells, a 100,000-ohm resistance box, and a paraffin pole changer which scientists in those days called a 'gyrotrope' (ha, ha!); it was nothing but a slab of paraffin with six round holes that were filled with mercury. By making copper-wire connections and U-shaped pieces, it formed a handy way of making changes in the direction of the current and other kinds of connections.

The hood on the testing table served as a little darkroom, and had black curtains which could be pushed aside(3) when adjustments were made; the reflecting galvanometer stood under the hood, as did the scale with its kerosene lamp. Behind the testing table on the wall are the shelves on which the battery of standard Daniel cells stood. Taken at 1.079 volts a cell, we determined the voltage of a machine, a lamp, or any line. It must be remembered that at that time there

(3) Vol. I, *Menlo Park Reminiscences*, p. 371.

existed no direct reading instruments. Voltage and webers (later called amperes) had to be determined through indirect methods that required much time.

When I installed the testing department in the Goerck Street works, the wooden hood described above was discarded, as the testing room was dark. Over the testing table, fastened onto the ceiling, two flat iron supports were suspended. They held a long, narrow piece of wood on which were numerous binding posts in connection with the dynamo room, photometer room, and so on. From these binding posts, connecting pieces of wire served to connect the testing table with its instruments to the outside objects whose high resistance or voltage was to be determined. The photometer room in the Goerck Street works adjoined the testing room described above, and here our old modified Bunsen photometer found a place.

The standard of light at the time was the English spermaceti candle that was supposed to burn at a consumption of 120 grains an hour. The unit of light, as well as the mean horizontal or spherical candle power, had not been standardized, and each country had its own unit. In England and in this country, the spermaceti candle burning at the rate of 120 grains an hour was the standard. The Germans had the Hefner unit; this was a lamp burning amyl acetate. The French standard was the Carcel lamp, burning pure colza oil. (4)

The writer had worked and experimented with these three units, but had not found any of them very constant or accurate. For practical pioneer work, the British candle unit proved the most convenient and handy. The Edison form of the Bunsen photometer is shown on page 960; it consisted of the Bunsen principle on wheels. Bunsen, it will be remembered, took a piece of dull white paper and framed it. In the center he made a grease spot, or a starlike figure, with stearin or paraffin. In order to see both sides of the spot easily, he placed mirrors at equal angles on either side of the paper, as shown in the illustration. Then by placing a source of light on one side of the grease spot, and another one on the other side, and moving the grease spot to the right or left, a point was found where the grease spot disappeared. The values of each of the two light sources were to each other

(4) Taking the British spermaceti candle as 1, the Hefner unit was 0.9 and the Carcel, 9.6.

as the respective squares of their distances from the grease spot. Later, we used seasoned incandescent lamps as standards; these had been determined several times with the standard candles by different persons.

The Edison incandescent lamp soon led others to establish a more definite unit and system of notation for the light intensity of a lamp. Out of the wider and wider use of electric lighting came the gradual fine improvements in photometric technics.

In the testing room in Goerck Street on the east and south sides, Edison placed ten huge hogsheads about five feet high; in them he placed large copper resistances shaped somewhat like the small ones shown in Volume I, page 246. The hogsheads were filled with water and were to be used for loading the different types of Edison dynamos during their testing. It was found, however, that they were not practical for the work—in fact, they were a failure.

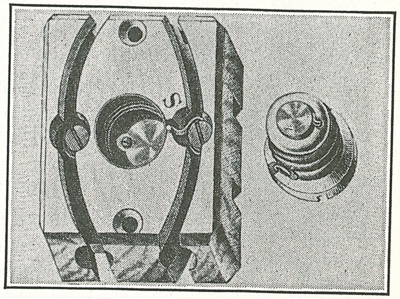
Edison then had 1,000 sixteen-candle lamps hurriedly mounted on the rafters of the testing room; the lamps were to be used as load in testing his dynamos as they came finished from the shop. They were so arranged that by means of plug switches, any number of lamps could be inserted, depending on the size of the dynamo under test.

I installed a gold-plating outfit in this testing room; it was necessary to gold-plate the ends of the copper bars and the cross-connection plates of Edison's steam dynamo armature. This was done to insure good connection conductivity and to prevent corrosion.

Toward the street from the testing room, there were two 'A' Edison dynamos which formed part of the equipment for training young men who were later expected to do outside work in installing the Edison system. They were taught how to pack and unpack an Edison dynamo, how to build a foundation, and how to mount the dynamo and start it running. They were shown how to connect the field magnet according to the direction in which the armature was to run, how to adjust the commutator brushes, and how to start the dynamo. Frequently, the field magnets would not respond, and it seemed that the machine could not generate current, since the magnets had lost all traces of any magnetism. Our old Menlo Park trick was to take a bluestone or a Daniel cell and to connect its proper poles to the extremities of the field magnet's windings.

In this school of instruction, the young men were also taught how to install wiring, how to select the proper size of wire necessary for a certain number of lamps, how to make wire connections and solder them, and how to mount the old wooden cutout blocks with wooden safety plugs. In fact, they were initiated in those pioneer principles and accessories with which the industry and art started at the old Goerck Street Machine Works. From there many young men went out into the world to install the Edison system; subsequently, they became leaders in the profession.

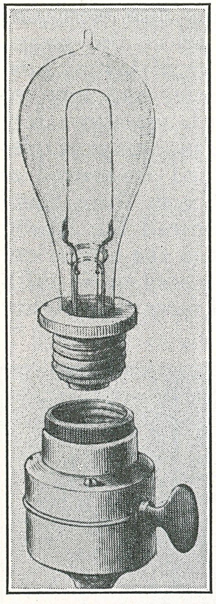
A little later Clarke started a similar school at 65 Fifth Avenue and printed a neat little booklet of more than eighty pages of instructions and twelve drawings for the pupils. The booklet was printed and circulated only among Edison men. The men I had in the school in the Goerck Street works had the advantage of getting well acquainted with the Edison system, for they worked with the tangible parts of the system. It often happened that after the men of Clarke's school had finished their courses at 65 Fifth Avenue, several were sent down to the Goerck Street works to brush up on the real parts of the system.



The blocks and safety fuse were made of wood.

Edward H. Johnson was then busy in England. When he had finished his work there and had returned to America, he occasionally gave a talk. To Clarke's guidance belongs the credit for starting and running the school at 65 Fifth Avenue, while the writer started the one in the Goerck Street Machine Works.

The first young man who left the Goerck Street school was W. N. Stewart who was sent in the fall of 1881 to Santiago, Chile, where he installed a 'Z' Edison-type dynamo to operate sixty of the 'A' lamps in a variety theater. Stewart did well in Chile and organized Edison plants in various places. In the fall of 1882, he started a small central station with three 'Z' dynamos. The station grew, and in



The Edison lamp, base and socket in those first days. The lamp base was put together with plaster of Paris. Such a lamp can be seen in the Edison historical collection in Dearborn, Michigan.

1883 an Edison Jumbo dynamo was installed—later another was added. In October 1883, the Santiago Central Station was serving about 110 consumers and was wired for 2,500 sixteen-candle lamps.

Another capable man at our Goerck Street school was R. A. McCarty. He was sent to Rio de Janeiro to exhibit the Edison system at the National Industrial Exhibition which was to open in December 1881. The Spanish syndicate which had introduced the telephone in Brazil was the same one that obtained a concession for the Edison system.

It so happened that my good friend and classmate, William I. Donshea, who had studied with me at Cooper's Institute, had entered the services of the New York Telephone Company early in 1879. Donshea possessed ability and push and was soon promoted to inspectorship. In November 1880, he was sent to Brazil to install an exchange. When McCarty arrived in Rio de Janeiro, the syndicate asked Donshea to assist him. When the exhibition was over, Donshea installed the Edison system at the Don Pedro Segundo Railway Station in Rio de Janeiro.

Thus, the work that Donshea accomplished in Brazil in 1881 made him an Edison pioneer. In 1887, he entered the services of the Edison Illuminating Company of New York and was promoted to electrician and superintendent. I well remember the dinners that we extended to Stewart and McCarty when they left for South America. The Stewart dinner was given at that old and well-known restaurant of Smith and McNeil's, while the dinner for McCarty was at a Spanish Hotel on the west side on Ninth or Tenth Street. McCarty later on made many inventions, including the cash-carrier system still found in many business places.

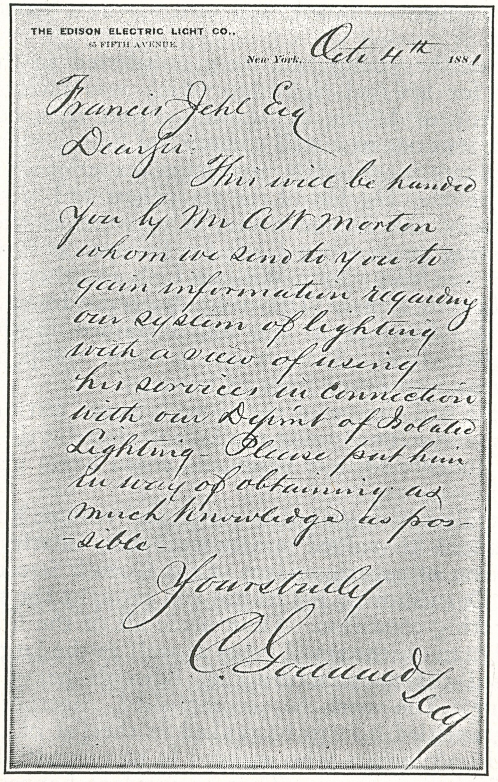
As I have said, many young men were sent down to me

from headquarters at '65' during the summer and fall of 1881. I remember when Major Eaton sent Charles Wirt, a man who succeeded in life and became well known to the profession. Then there was A. W. Morton, whom Colonel Goddard, secretary of The Edison Electric Light Company, had sent. Among those who commenced work with the Edison interests in 1881 on Goerck Street were George G. Grower, Frank A. Wardlaw, John C. Hatzel, and others whose names I have forgotten.

Most of the young men were transferred to the Edison company for isolated lighting, which was under the able management of Miller F. Moore. From that department they were sent out to install commercial Edison plants and to operate plants for a while after more experienced men had installed them. The list of the staunchest and most faithful supporters of the Edison cause, who were at the Goerck Street testing room when I left for Europe on February 22, 1882, was headed by John William Lieb and then in 1883 by Charles Leavitt Edgar. They were determined men who had served the Edison cause and had remained in the service during their lives. Some went in with competitors and others went into other lines of business.

While I had charge of the Goerck Street testing room, I also spent some time giving the Edison electrolytic meter the finishing touches so that Bergmann could begin manufacturing it.

I have already described in my second volume how Edison had advanced his valued master mechanic, Charles Dean, to the position of superintendent of the Goerck Street Machine Works. Dean showed his mettle and brought the shops into fine operating condition. Dean made all of the first pioneer Edison dynamos, the small types as well as the large Jumbos. He started the manufacturing of Edison's heavy electrical machinery. The work he accomplished, together with his abilities, entitled him to be ranked in the list of those foremost Edison pioneers who assisted in so successfully launching the lighting system. That an incident happened which forced him to leave the Edison interests was in itself deplorable; yet, no one can fail to recognize his valuable support to Edison and to the system.



THE EDISON ELECTRIC LIGHT CO.,
65 FIFTH AVENUE.
New York, Oct 4th 1881

Francis Jehl Esq
Dear Sir:

This will be handed you by Mr A.W. Morton whom we send to you to gain information regarding our system of lighting with a view of using his services in connection with our Depmt of Isolated Lighting. Please put him in way of obtaining as much knowledge as possible.

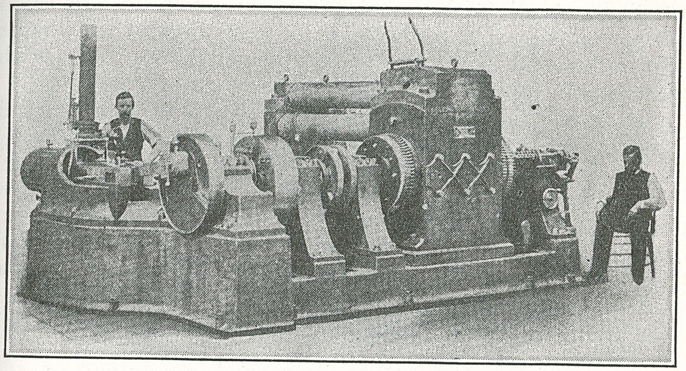
Yours truly
C. Goddard
Secy

XCVI. Goerck Street Associates

(MORE ABOUT THE JUMBO)

THE first Edison dynamos began to appear during the summer of 1881, and soon all the different sizes were available. For a time, the Edison dynamos appeared to be very rough, because Edison thought that it was not necessary to give a finish to those parts of the machine that did not require it. He stressed the necessity of spending money and time only on those parts vital to enhancing the efficiency of the machine; thus, some observers said that the dynamos looked like stamping or crushing machines. The dynamos were simply painted gray, while the machines of competitors were handsomely finished and artistically painted. Later, Edison gave more attention to the general appearance of his machines and products, as several persons impressed him with the slogan, 'Clothes make the man.'

Not only were the machines made to appear more appealing, but also Mrs. Mary Stilwell Edison tried to get her husband to dress befittingly; from the photograph on page 924, we perceive that she was successful. In summer, Edison came to the Goerck Street works in a light gray cutaway suit and a gray high hat, with necktie to match. One thing,



Edison Jumbo Steam Dynamo No. 1. This Jumbo was sent to the Paris, France, International Exposition of Electricity, in 1881

however, which he never had was a cane, although it was the fashion to sport one.

My desk was situated in the center of the testing room. Edison often came in when he had something to communicate or to request, or when he wished to rest. He always had about three boxes of cigars in my desk. When he came in, he would open the drawer, take out a cigar, and sit down to smoke, usually resting his feet on the table. He had told me to help myself whenever I wished; of course, I did not refuse his offer.

In those days, a spittoon was always near-by, and Edison, who was an expert, could hit the bull's-eye whether he was smoking or chewing tobacco. Now and then the cigars vanished too rapidly. We became wise to the fact that someone was occasionally sneaking into the testing room and purloining some of them. I told Edison that I would keep them under lock. He called in Dean, who also had the privilege of smoking free cigars and who generally had a stock of a half-dozen boxes in the office. (I am quite sure that Berggren will remember the incident, for he had been transferred from Menlo Park to assist C. E. Rocap, the bookkeeper of the Edison Machine Works.)

'Dean,' said Edison, 'you know the store where they make cigars just around the corner on Grand Street.'

'Yes,' replied Dean.

'Well,' continued Edison, 'send someone to order a box of cigars made with fine Havana wrappers and have the fillings consist of Saturday night's sweepings of that barber shop where all those foreigners go—you know, here in the next block.'

Dean had the order carried out. A few days later I needed something for the testing room and went to Dean to have it made. While talking, he reached for his cigar box, took out two cigars, and offered me one. He lit his cigar and extended the light to me. I thanked him and told him I had just finished one and would smoke his later. After putting the cigar into my upper vest pocket, I left. When I returned to the testing room, I broke the cigar in two and found that it was all right. Dean had failed in his sleight-of-hand trick, for he had taken the one with the sweepings.

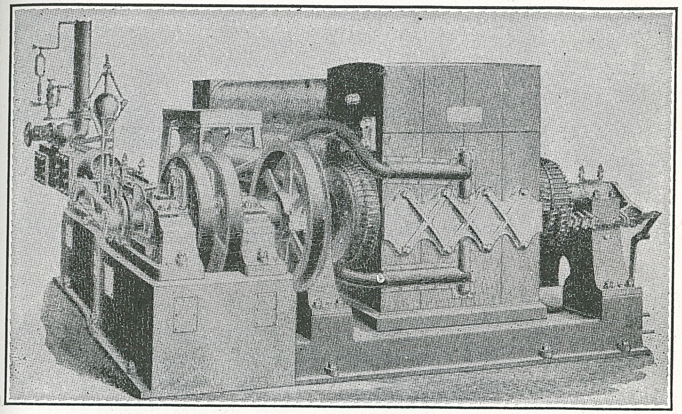
Later that day we met, and looking him in the face, I told him that the cigar he gave me was fine. He averted his gaze and turned away scowling. This was not, however, the

end of the joke. Dean handed me half a box of the cigars which were filled with sweepings (he had kept the other half for his friends), and told me to let Edison see them. I showed them to Edison, and we arranged to put them into the drawer where I usually kept the real cigars and put the good ones in the photometer room near-by.

It soon appeared that the cigars (with sweepings) had found a customer when one evening Edison said, 'Francis, those are darn bum cigars you have in that drawer,' spitting as if his tongue were entangled with something. I laughed aloud and told him that the good cigars were in the photometer room, as we had arranged.

'I forgot,' was all he said. He kept spitting as he went to the photometer room where he filled his vest pockets with good cigars and lit one as if it were a great relief to him. Edison frequently related this incident to friends when jokes and tales were the order of the occasion. Writers and dinner speakers used it in talks and twisted the original story for their purpose.

Almost daily Clarke was at the Edison Machine Works conferring with Dean on some matter concerning the manufacture of the dynamos. The construction of the first commercial Jumbo was then in progress and Clarke had plenty to do. He and Edison were in the machine works most of the time.

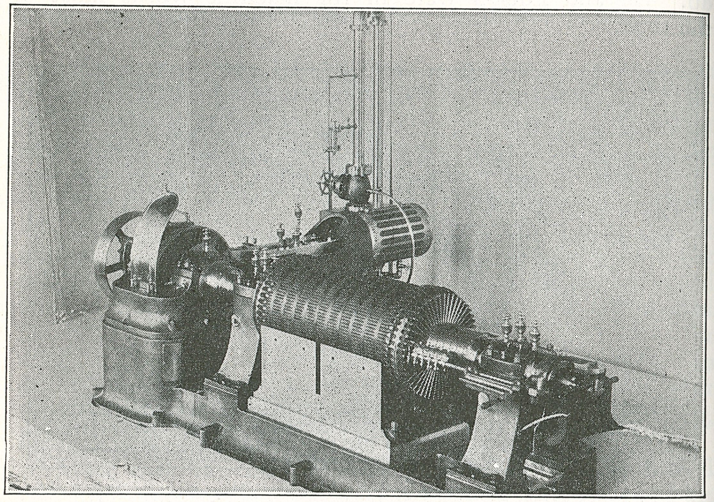


Edison Jumbo Steam Dynamo No. 2, with Porter-Allen engine. This Jumbo was sent to London, England, for the Holborn-Viaduct Edison Station.

It will be remembered from Volume II that Clarke had designed, as his maiden effort, the experimental steam dynamo at Menlo Park. From data obtained, the first commercial dynamo was built in the Goerck Street works and was known as Jumbo No. 1, or the Paris dynamo. When finished, it was sent to the Electrical Exposition in Paris, France, early in October 1881. It was to have been sent to Paris some months earlier, but insurmountable obstacles delayed the work; however, Edison was able to put the dynamo on exhibit before the exposition closed.

The dynamo was the largest ever built, and it created a furor among engineers. Electricity was in its infancy when Edison began his great work. Many considered it a weird thing that had no practical application aside from telegraphy, call bells, and plating. A few crude generators had appeared, yet many thought it impossible to generate huge quantities of electricity. With Jumbo No. 1, Edison opened the way for the erection of central-supply stations—a thing many men considered impossible.

I well remember the long nights spent in the Goerck Street works, testing the first Jumbo dynamo. I did all the electrical testing, often measuring the resistance of the armature to see if any connections were loose, and measuring

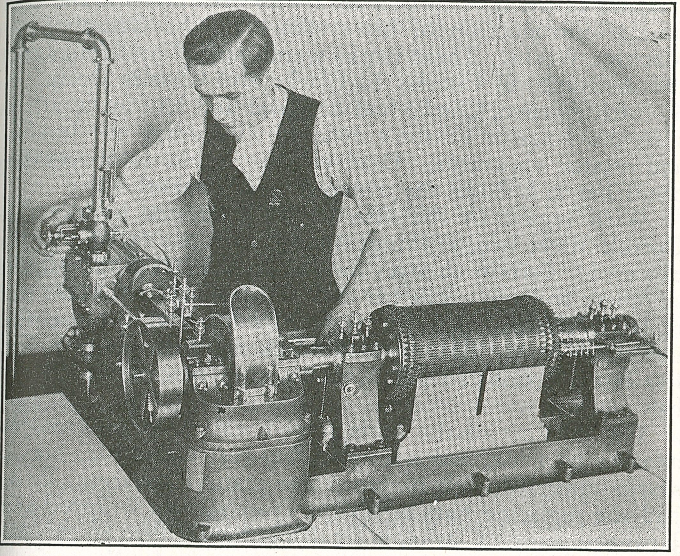


Working model of Jumbo No. 9 (see cut on page 971).

the drop of potential between each connection of the copper bar and disc. As Edison directed, I varied the lamp load and gold-plated all the connections and screws used in the armature. My anode was a ten-dollar gold piece; it was of sufficient size for the small surface to be plated. The solution used was 100 parts of water, two parts of cyanide of potassium, and one part of gold that had been converted into neutral chloride.

When tests were being made with various loads, I measured the voltage and also plotted curves. Clarke was busy measuring the power of the steam engine with the steam indicator —a little instrument screwed to the small opening into the cylinder of the engine. When the indicator diagram records had been closely studied by Edison and Clarke, performance of the engine (that is, the steam in the cylinder) could be ascertained.

I usually assisted Clarke in obtaining the area of the diagram with a planimeter. Clarke would keep on making



The above picture shows a one-quarter-sized working model of Jumbo No. 9, made by a Henry Ford Trade School student. The upper field magnet was taken off in order to obtain a good view of the armature. Can be seen in the Edison historical collection in Dearborn, Michigan.

diagrams faster than an automatic cruller machine could send out doughnuts, while I was busy getting the areas of the curves. Clarke liked this kind of work, for he could see from those closed curves of the diagrams the performance of the steam engine; he could detect obscure points that not only related to the construction of the engine, but also to actions of the working parts. Often the valves of the engine were reset.

Clarke was at the height of his profession as a mechanical engineer. I often thought that if he had possessed the instant volubility of Johnson, many things in Edisonian history relating to the loyal and meritorious men of the pioneering period would have been written differently; credit would have been distributed accordingly long before I had been prompted and destined to do it.

I have told of the great assistance given to Edison by Batchelor and Upton in starting the first commercial lamp works, by Bergmann in founding the electrical accessories factory, and by Kruesi in starting the Edison underground electric conductor (or tube factory). The last to complete the creation of the new Edison industries necessary for the commercial introduction of his system was the Goerck Street Machine Works. These works were founded by Edison with the assistance of Charles L. Clarke and Charles Dean. At 65 Fifth Avenue, Clarke had designed and had made all the shop drawings of Edison's dynamos (including the Jumbos) and related apparatus. Dean put the works into operating condition and made the dynamos and Jumbos.

With regard to the first Jumbo generator built at the Goerck Street works, things did not turn out so well as was expected. Certain changes had to be made that retarded its shipment to Paris. The bar conductors of the armature were replaced because they were so crowded and because they generated heat. Edison replaced them with others having less cross section, so placed as to leave space between each bar.

Bar winding of the Paris Jumbo was insulated from one another by mica, and when the first test was made, big, fat sparks appeared. To prevent these static discharges, Edison had the replacing bars of smaller cross section wrapped with Japanned paper. Clarke, in recalling this incident to me, said: 'You remember how that occurrence surprised us?'

The heat, however, was greater when we tested the new bar winding, because the armature had had its resistance

increased. For the time being, Edison decided to put in a blower for ventilation. I remember that Edison once discussed the idea of trying upright copper strips, equal in cross section to those of the square ones, because they were less apt to create Foncault currents than the square bars. That idea, however, would have necessitated making the iron laminated core of the armature of less diameter, and would thus have increased the magnetic resistance by widening the distance between poles and core.

There was also another obstacle. When we started to run the generator for a test at full load, we found that our voltage was not high enough. Then Edison decided to put two extra magnetic field cores in parallel upon the three upper magnetic cores. He thus had a huge, irregular, compound bipolar field magnet having three magnet cores on the bottom side and five cores on the top side. It was not, of course, an ideal magnetic circuit, but as time was pressing for delivery, any means to obtain the desired results was considered permissible. The tests with the added field cores and increased tension satisfied Edison for the time being. He considered that the steam dynamo was now in good order and could be packed up.

As it was Saturday midnight, and as the packing would not take place until later, the idea came to Edison to test the steam dynamo for an hour or so. Clarke, Dean, a few of Dean's men, and I were present.

'Warm her up,' Edison said, and the engine driver commenced to let steam into the cylinder slowly. After a little while Edison nodded, and more steam was turned on; the engine began to turn. Then, suddenly, there was a crashing, grinding sound, and the engine driver instantly turned the steam off. An examination followed immediately, and Clarke, standing by the Armington & Sims engine, saw at once that the six-inch, cast-iron shaft had broken off at the crank disc. Edison shook his head and expressed his surprise (in language hardly fit to record) that cast iron had been used for a shaft of that importance.

It was an act of providence that the break had not occurred when the steam engine was running at high speed; otherwise, Clarke would never have been able to celebrate his eighty-sixth birthday. Why that shaft broke just when the engine was started and not when under heavy load at high speed

was never explained. Yes, some of us would surely have accompanied Clarke.

Dean and his men went into action and in twenty-four hours had finished a new shaft of steel. The night that the new shaft was mounted, we stayed up late to give the engine, as well as the dynamo, a thorough testing and we achieved gratifying results. As my old colleague Clarke said, 'The construction of the first successful, direct-connected steam dynamo was far greater in size and capacity than any machine made up to that time; it became the prototype of the colossal, direct-connected, steam-driven electric generators in use throughout the world today. Many discouraging obstacles were encountered in the perfecting of this machine, and much experimentation was required to overcome them.'

This is what the able and eminent Professor Michael Pupin, of Columbia University, said, 'A very essential element in Mr. Edison's electrical lighting system that represents "another epoch-making achievement" is the invention and development of the low-resistance dynamo electric machine.'

Edison was the only one who needed a shunt-wound dynamo in 1879, for he was the sole inventor of the incandescent lamp which required a constant potential; he evolved the parallel system in use at present.

I remember when the newspapers stated that a celebrated electrician of Cleveland, Ohio, to whom Edison had shown everything at Menlo Park, ridiculed Edison's lamp and the idea of using an adjustable resistance in line with the shunt of the field magnet to regulate the voltage and keep the potential a constant factor. That same electrician, who had commenced in arc lighting, later recognized the immense value of Edison's lamp and system. He went abroad and bought the infringing product of a foreign pirate to compete with Edison.

When the Edison Jumbo was shown at the International Electrical Exhibition in Paris, it was hailed as one of the seven wonders of the world. It created astonishment among engineers, and was considered a veritable epoch-making achievement. The engineering journals of all countries gave a detailed description regarding its construction.

The best detailed explanations are found in *Edisonia,* a book published by the Association of Edison Illuminating Companies in 1904. In this book, Charles L. Clarke, who designed all the Jumbo steam dynamos, gives the most

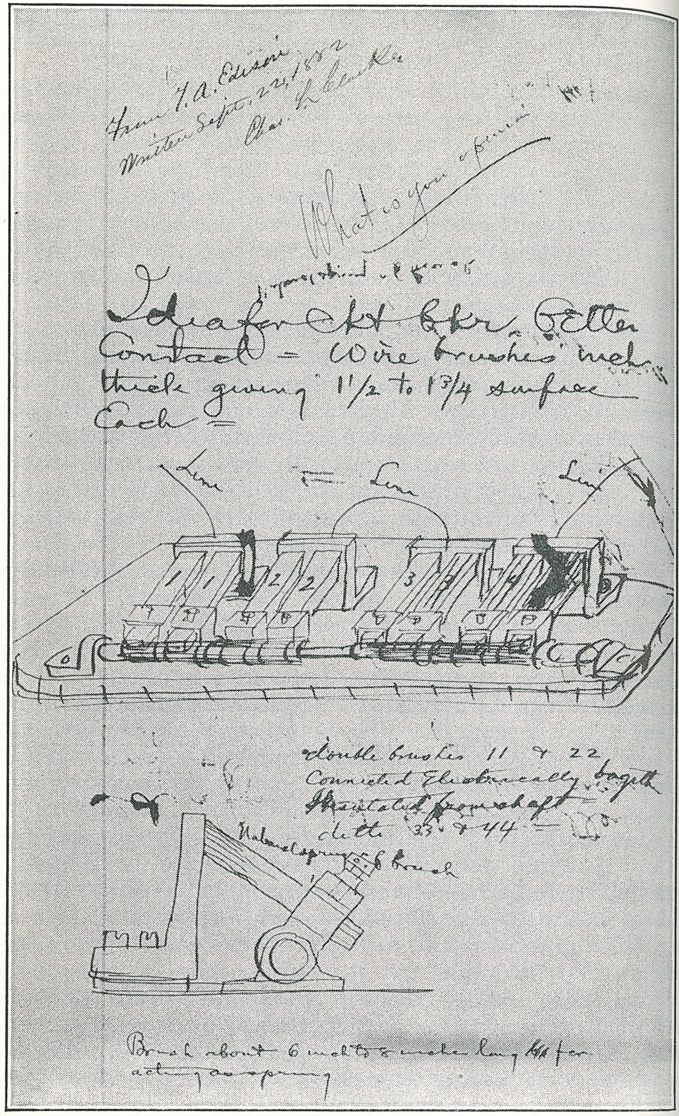
exhaustive study, history, and details of the pioneer efforts which led Edison to erect the first central station in the world for delivering electricity for light, heat, and power.

That pioneer station was equipped with eight Jumbos. Jumbo No. 1 was capable of delivering continuously 500 webers (amperes) at 103 volts, which meant about 714 A. sixteen-candle lamps of those days. The lamps operated at 0.7 weber (ampere) and consumed 4.5 watts per candle. The steam engine made 350 revolutions per minute and was manufactured by Armington & Sims at Lawrence, Massachusetts. The steam boiler pressure was about 120 pounds. The internal resistance of this armature was 0.0092 ohm.

Early Monday morning, when Jumbo No. 1 had been taken apart and all its parts packed into cases and crates (already made in advance), the Goerck Street works had an unusual appearance of activity. The trucks came and the cases and crates were loaded; policemen accompanied the caravan as it left. Edison had requested Jim Russell, our private detective, to get special permission from the city authorities for the right of way through all streets from the works to the dock where the steamer for Europe was to leave in a few hours.

People wondered what it was all about—policemen clearing the road ahead for the loaded trucks, all amid the shouting and swearing of teamsters. Jumbo No. 1 was safely loaded into the hold of the steamer. If Edison had not requested the aid of the police, the trucks would never have arrived in time. One must not forget that the weight of the whole unit was more than 60,000 pounds, excluding packing.

One of the passengers on the steamer was our William J. Hammer, who had been in the lamp works at that time. Edison was sending him to London, England, to assist E. H. Johnson in the work of demonstrating the system on a large scale; Johnson was Edison's representative in England. Charles Batchelor had already been sent to France to install and to take charge of the Edison exhibit; then he was to install lamp and machine works for the French Edison companies. Batchelor had left for Europe with his family on July 20, 1881, on the steamer *Amerique;* he was Edison's European representative. His efforts and work were of great value in launching the system on the continent. Clarke had made two sets of shop drawings of the Jumbo for Batchelor, who later built two of these steam dynamos at the French Edison Machine Works in Ivry-sur-Seine, France.



A draft that Edison drew of a heavy circuit breaker and sent to Clarke.

CHARLES L. CLARKE, April 16, 1903.

XCVII. Memories of the New York Shop

BACK at the Goerck Street Machine Works in New York City, Dean was turning out Edison dynamos of various sizes during the summer of 1881. The following are the types that Edison and Clarke designed; these are characteristic of the era of the introduction of the Edison system here and abroad:

Type	'E'	for	15	lamps of 16 candles	
"	'Z'	"	60	" " " "	
"	'L'	"	150	" " " "	
"	'K'	"	250	" " " "	
"	'C'	"	1,000-1,200	" " " "	Jumbo type.

Some of the Edison dynamos were built for fifty-five volts for 'B' lamps that gave eight candles; these necessitated only half the voltage of the 'A' lamps of sixteen candles. As seen in the illustrations, the 'E' and 'Z' type dynamos had one tall vertical field; the 'L' type had two fields compounded; and the 'K' type had three. When we compare these electric generators with those that existed previously,

we recognize the great advance Edison made in their construction and efficiency. Other machines had but little iron; their makers knew little about magnetic saturation and other features which Edison and Upton had worked out.(1) Edison had introduced mica as insulation for the commutator; he had tripled the number of commutator bars on his machine. The following table will give a few data regarding the first dynamos made at the Goerck Street works for 'A' lamps:

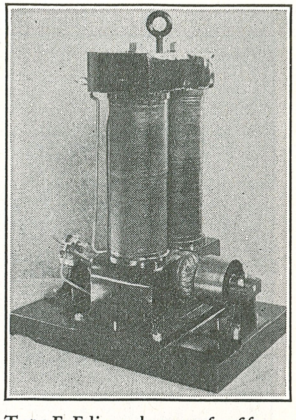
Dynamo type	'E'	'Z'	'L'	'K'
Commutator bars	24	74	54	64
Armature resistance—ohms	0.36	0.14	0.068	0.032
Revolutions per minute	2,200	1,200	850	900
Length of magnet core	17¼	42 13/16	42 13/16	42 13/16
Diameter of magnet core	4¾	6½	6½	6½
Resistance of field magnet—ohms		40	20	13

When Edison introduced his system of parallel distribution and lighting with his incandescent lamp, he was the only one who needed a new kind of dynamo machine. Others were pushing the arc-light system, and they used the series machines, which required a constant current and a variable voltage—the exact opposite of Edison's system, which used constant voltage and variable current. His system was flexible; one could use all or part of the current, and switch it in or out any time without disturbing the equilibrium of supply or voltage.

The science of dynamo building was not yet established; it was mostly guesswork and phantasy. Upton gathered data pertaining to the magnetic circuit. As was described in Volume I of *Menlo Park Reminiscences*, he had found the value of ampere turns and their relation to the generation of magnetism—later called magnetic flux. Upton found that iron could become saturated; therefore, the cross section had to be considered. He studied various kinds of iron and the state in which they were used—whether solid or laminated, hard or soft. Thus, the pioneer dynamo, constructed on the principles found at Menlo Park, was recognized as the model upon which scientific men wrote theories of dynamo design.

While we were at Menlo Park, one joker christened the dynamo the 'Long-legged Mary Ann,' because of its tall

(1) Vol. I, Chapter XL, *Menlo Park Reminiscences.*

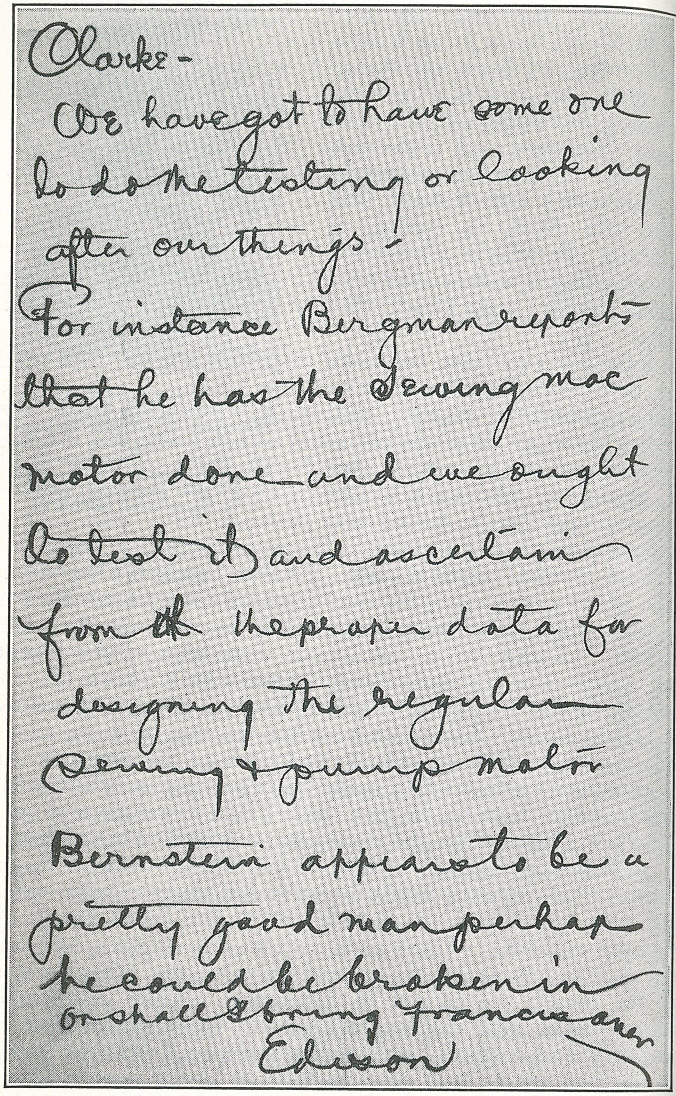


Type E, Edison dynamo for fifteen-A., sixteen-candle power lamps. The height of this pioneer generator from base to yoke was thirty-one inches. This dynamo did service in Japan. Can be seen in the Edison historical collection in Dearborn, Michigan.

field magnet. Edison used the drum-type armature patented by M. Henri Louis Felix Worms de Romilly, of Paris, on March 3, 1866; he applied the commutator invented by Dr. Antonio Pacinotti, of Florence, in 1860. It was the principle of Pacinotti's commutator that gave the world a means of utilizing Faraday's discovery, by designing dynamos that produced steady and direct currents.

Edison's task was to make the commercial generator convert mechanical energy into electrical energy most efficiently. He had to create a new type of generator—one with a low armature resistance, which was necessary for the system of parallel current distribution. Edison succeeded in doing this, yet it seemed possible then to make the dynamo cheaper by redesigning the field magnet and by making the cores shorter. There were discussions concerning this point, and when the dynamos were commercially made at the Goerck Street works, the core lengths were greater than those at Menlo Park. Edison knew what the magnetic resistance indicated, yet with regard to the length of the cores, it was an anonymity why he had made them so long or why he had compounded them for larger sizes. These types became well known in England, on the continent, and in the United States.

In February 1882, I was sent to The Edison Electric Light Company of London, England, with the electric light meter, and was introduced to two bright young men, Dr. J. A. Fleming and Dr. J. Hopkinson, whom the English company had engaged to act as their scientific advisers. During tests of our meter, we talked of generators. They asked why Edison made such tall magnet cores. I told them that he probably had in mind Jacobi (who considered that the power of electromagnets was proportional to the diameter of the iron cores and to the square root of their length).

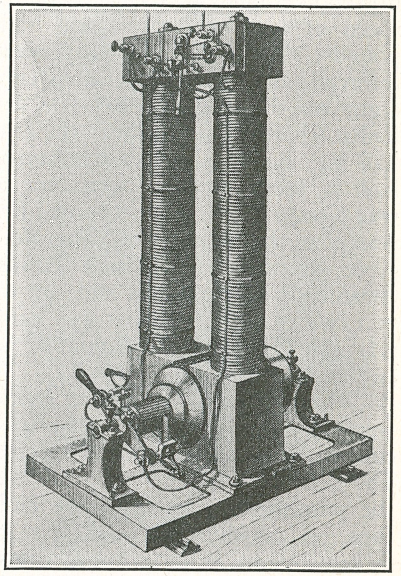


Clarke—
We have got to have some one to do the testing or looking after our things!
For instance Bergman reports that he has the Sewing mac motor done and we ought to test it and ascertain from ~~th~~ the proper data for designing the regular Sewing & pump motor
Bernstein appears to be a pretty good man perhaps he could be broken in or shall I bring Francis over
Edison

In April 1883, while in Austria, I read in the London *Electrician* that Dr. John Hopkinson said, 'That he had succeeded in greatly increasing the capacity of the Edison machines without increasing their costs, and with a small increase in percentage of efficiency—remarkably high as that efficiency already was.'

Hopkinson had been working many months on the Edison machine at Mather & Platt, in Manchester, where the machines had been built for the English Edison company. He had increased the efficiency, decreased the speed, decreased the cost per lamp, decreased the machine's weight, and had replaced the multiple magnet by a single one of the same cross section. His was a fine piece of work, and from those investigations of 1883, the Edison-Hopkinson generator was developed.

Although the pioneer dynamos were the most efficient machines on the market then, they were still capable of some improvement had we applied the laws and data obtained through experimental research work at Menlo Park. The 'A,' 'E,' 'Z,' 'L,' 'K,' and 'C' types of generators were crusaders which brought the Edison system into every part of the world. For the electrical fraternity, these *first generators* for parallel distribution were the only ones. Today, they are in the Edison historical collection in Dearborn, Michigan.



Type 'Z' Edison dynamo for sixty-A, sixteen-candle power lamps. The height of this pioneer generator from base to yoke was about sixty-one and a half inches. This pioneer generator can be seen in the Edison historical collection in Dearborn, Michigan.

The generator of greatest significance and historic value in this group is the 'C' or Jumbo type. It is the only Jumbo which was saved

when the world's first central station burned on January 2, 1900. It will always remind us of the founder of central electric supply stations. The last line on the note from Edison to Clarke (on page 980) which says, 'or shall I bring Francis over' refers to my humble self. I was already in Europe and it was my lucky star that I was not called back.

When the Paris Jumbo No. 1 had been safely stored on the steamer, Edison and Clarke conferred upon matters regarding the building of Jumbo No. 2, and decided to make a more powerful dynamo. After Clarke had finished the shop drawings for Dean, the work of construction was soon under way. I gold-plated the connection parts of the armature and assisted in testing the unit as before. The tests were as vigorous as possible, and on the final test the machine ran for twenty-four hours. Fortunately, no mishap took place.

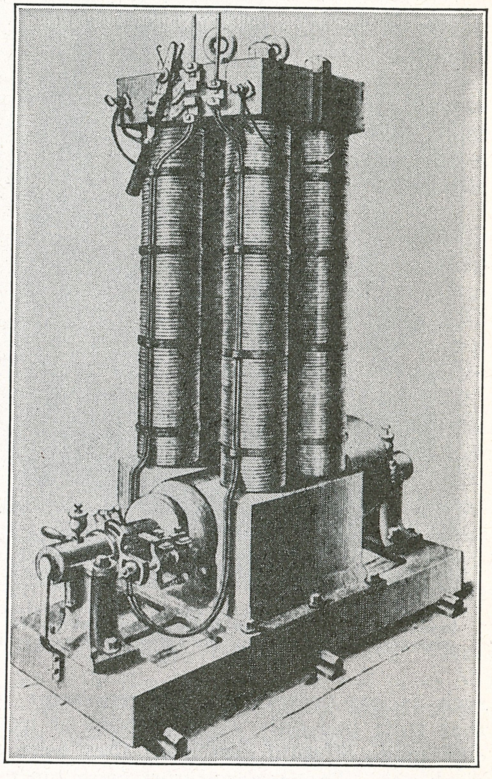
The dynamo unit No. 2 was connected to a high-speed Porter-Allen steam engine, which was rated at 125 normal horsepower and at 200 maximum horsepower; it ran at a speed of 350 revolutions and had a steam pressure of 120 pounds. The magnetic field system in Jumbo No. 2 was reinforced, as it had four electro cores at the bottom side and eight on the upper side. The armature winding of No. 2 had 106 bars on the surface; the armature of the Paris machine had 146 bars and the commutator had 73 sections—No. 2 had 53 sections. The armature resistance of Jumbo No. 2 was 0.0049 ohm and was cooled by an air blast when its load was near the maximum. The No. 2 unit had a capacity for 1,000 sixteen-candle-power lamps. The amount a lamp consumed, at 103 volts and 0.7 weber (ampere), was about 72.1 watts, or 4.5 watts per candle power. This dynamo was sent to London, England, to demonstrate the Edison system.

When Jumbo No. 3 was started, several minor changes were again made. The capacity of this generator was calculated to handle 1,200 'A' lamps of sixteen candle power. The resistance of the armature was reduced to 0.0039 ohm; the winding on the armature had ninety-eight copper bars; thus its commutator had forty-nine bars. The unit was driven by an Armington & Sims engine with 125 normal horsepower and 200 maximum. The speed was 350 revolutions per minute, the standard for all Jumbos. When the building of this machine was started, I was still at the Goerck Street works. I gold-plated the connection surfaces of ends,

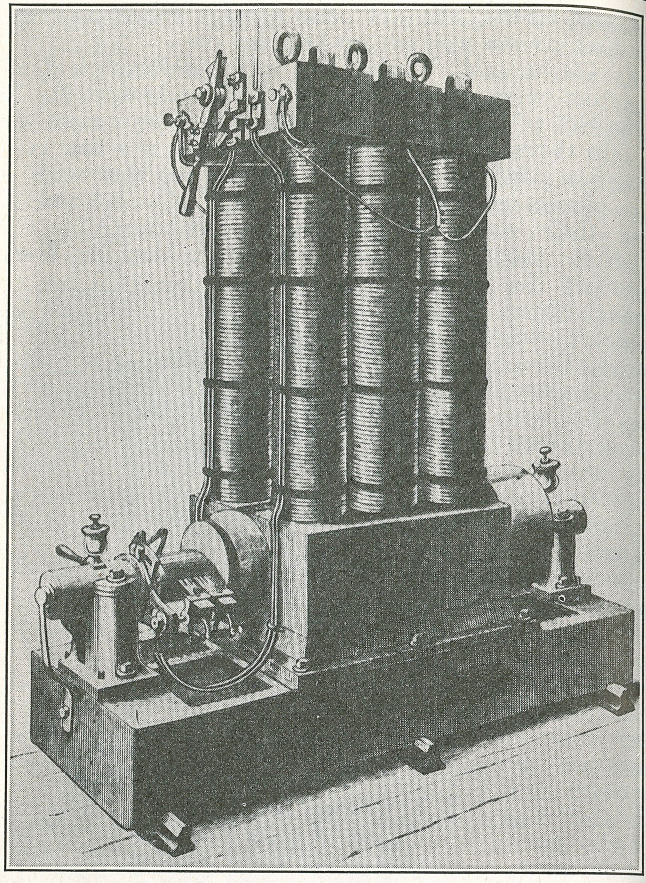
lugs, and screws, and did other work. When completed, this machine was also sent to London.

As Clarke said, 'Jumbo No. 4 and subsequent Jumbo generators were constructed and built substantially like Jumbo No. 3.' Twenty-three of these huge generators went out into the world to proclaim the coming of a new era in light, heat, and power. These Jumbos, together with the other pioneer generators, the types 'E,' 'Z,' 'L,' and 'K,' found their way into all civilized countries.

Edison, founder of the Goerck Street Machine Works; Charles L. Clarke, chief engineer; and Charles Dean, superintendent, were the men who attained their objective in starting and in establishing the newly created industry of heavy-current engineering. The history of the early days at the Goerck Street works in New York City has never been elucidated. The men who assisted Edison in designing and building those pioneer machines opened the eyes of the world; they saw that current could be produced as a commodity



Type 'L' Edison dynamo for 150 A. lamps. Height of this generator from base to yoke was about seventy and three-quarter inches. This pioneer generator can be seen in the Edison historical collection in Dearborn, Michigan.



Type 'K' Edison dynamo for 250 A. lamps. Height of this generator from base to yoke was about seventy-four and three-quarter inches. This pioneer generator can be seen in the Edison historical collection in Dearborn, Michigan.

such as gas or water. The generators in existence up to that time had only a few ribbons of iron and an armature core made of solid cast iron; they were the series arc-light machines. Those generators were built by guesswork, but the Edison machine for incandescent lighting was built after Edison had carefully determined in Menlo Park all the data relating to iron, amperes, and turns.

Upton's experiments are described in Volume I.(2) The art of dynamo building on scientific principles was started on a commercial basis in the Goerck Street Machine Works. It was the policy of the Edison company never to publish immediately any of the scientific findings, but rather to wait a while. In certain cases, however, it was necessary.

I once got quite a scolding from Edison. I was in Brunn, Moravia, superintending the installation of the Edison system in the Municipal Theater. I had written an article for the London *Electrician*, which appeared in their issue of November 25, 1882. In the article I gave pointers on how to construct a theater dimmer (which was the first to be made). I also theorized upon the principles on which Edison had built his dynamos. I heard from 'the old man,' and it was well that I was 3,000 miles away. He said in a letter: 'Francis, I don't mind your airing your knowledge, but it must not be at our expense. You must not tell them "why" we do this or that in building our dynamos. It is not necessary to let others know how dimmers are built.'

In 1882, electrical lighting was in its infancy. Edison, with his new system comprising the first practical incandescent lamp, the first efficient dynamo, sockets, switches, and fuses, had the eyes of the world focused upon him. The rivals who sprang up were pirates, and it was not at all necessary to give pointers to the brazen-faced buccaneers. So, of course, I put on the brakes and wrote no more articles that contained what are known as 'trade secrets.' Tangible evidence of Edison's work on the dynamo was left to scientists like Gisbert Kapp and the Hopkinson brothers. They expressed the rules that dominated the building of direct-current dynamos in clear mathematical language. Their theoretical investigations raised the efficiency of the Edison dynamo one or two per cent. They also opened the eyes of those who had worked by guesswork.

Just before I left for Europe, Edison requested Clarke to take John W. Lieb from the drafting room and place him in the machine shop in Goerck Street so that he might obtain some experience with the Jumbo units. At the same time, Edison wanted Clarke to have Lieb commence some experiments with the object of making a voltage indicator based

(2) Chapters XXXIX and XL, *Menlo Park Reminiscences*.

upon the telegraph relay principle which has been briefly described.(3)

To assist Lieb in the mechanical construction of the experiments, Edison gave him John Ott, that fine and dependable instrument maker who had served his great master all his life.

It was one of Clarke's daily duties to come to the Goerck Street works to make his inspections, to give advice, and to lay out plans for investigations as, for example, standardizing the alloy from which the wire of our safety fuses were made. The best results were found to be when the alloy consisted of forty per cent tin and sixty per cent lead. Then, too, Clarke determined the length of the wire and diameter of the safety fuses for different current loads. We must not forget that he had to spend many hours daily at the Pearl Street Central Station, when it was in the progress of construction, and at the office at 65 Fifth Avenue where many things demanded his attention, not forgetting his meetings with Edison for consultations on the many matters that constantly came up.

William S. Andrews remained at the Menlo Park machine shop until October 1881, and then was transferred to the Goerck Street Machine Works. When I left for Europe on February 22, 1882, Andrews succeeded me, taking charge of the testing room on that date, and he remained in that position until June 1, 1883, when he was transferred to the Edison construction company. After Andrews came Charles L. Edgar who remained a few months and then took up active work with the Edison company for isolated lighting. In 1887, he was sent to the Boston Edison Company as station manager; in 1889, he became general manager, and then rose successively to become its president, which position he held until he passed away on April 2, 1932.

Samuel Insull, as I have already mentioned, had full swing of the clerical and office work. I remember the nights when he had to come down to the Goerck Street Machine Works, and Edison, sitting in a chair by the Jumbo under test, would go through the correspondence. Edison would jot down a marginal 'yes,' 'no,' or a note. Insull then would give him a batch of letters to sign. Sometimes Edison would read a few but the greater part was always signed without reading. Insull would now and then linger on for a while to watch the

(3) Vol. II, *Menlo Park Reminiscences*, pp. 761-2.

test and then start back with the horsecar for '65.' He, like the other Edison 'boys,' had no special hours, and the time was passed between work and sleep.

The Edison industries had their bookkeepers and clerks who took care of their respective clerical work and accounts on which Insull now and then made a report. The Edison Electric Tube Works, that Kruesi started for Edison at 65 Washington Street, had Washington E. Smith for its bookkeeper; Mr. Patterson was the first draftsman; and John Langton was Kruesi's mechanical engineer. We must not forget Harry J. Martin, the bright office boy who was well-known to all the other Edison offices and who was now and then sent to Menlo Park with blank checks for Edison to sign when he spent his week ends there. In those days Insull was only Edison's secretary, as Meadowcroft was Eaton's secretary, and enjoyed none of that publicity that he cultivated later on when he was no longer in the employ of Edison.

The thing that many old-timers regretted was that Insull never had a mentor to consult with now and then. An old Edison pioneer said: 'Yes, he was able, but too confident in his ability to do most anything and in the correctness of his personal judgment, when he ought to have consulted others to get their opinion. Thus, he proved by events of later years, that he was too much of a snap shot, going off half cocked.'

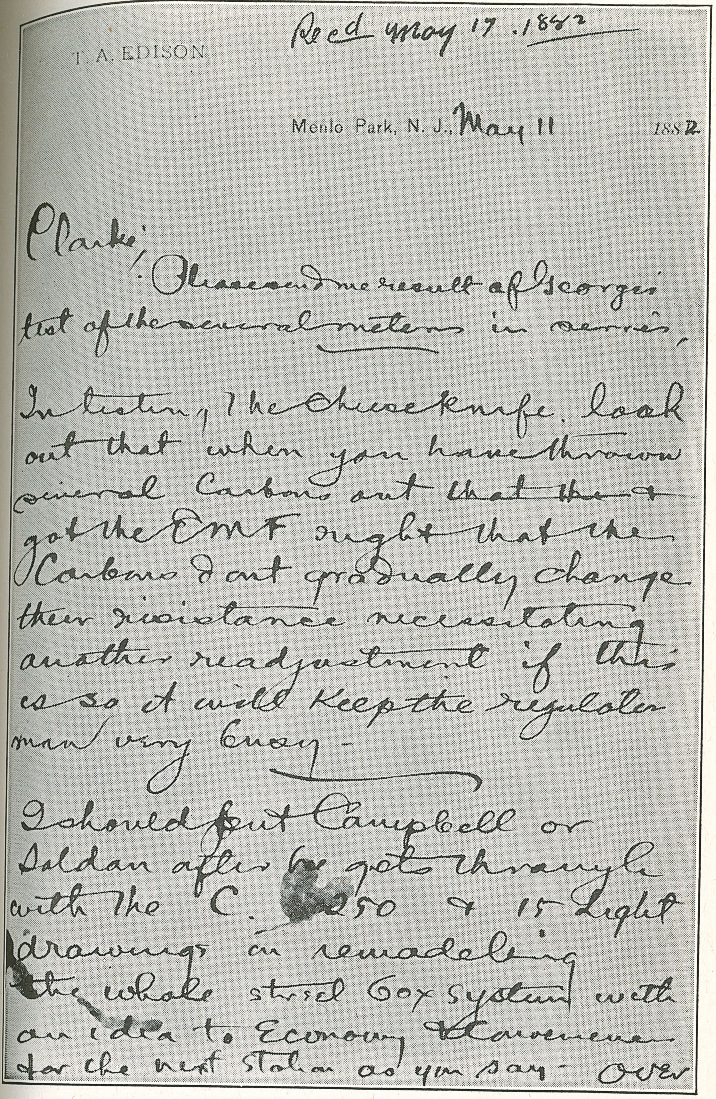
I may state that Batchelor, who went to Europe in 1881, and Kruesi, were both Edison's associates in taking part as partners to organize financially the Goerck Street Machine Works; but, as they were so occupied in other matters, it was Clarke and Dean who got it into operation and built with Edison the first series of the pioneer dynamos. When Dean was forced out, Soldan took his place and then was followed by W. M. McDougall in 1884. The machine works also had a supply and shipping department at 97 Sixth Avenue, New York City, of which Mr. Livor was in charge; here, also, H. A. MacLean was chief clerk. In 1883, MacLean was transferred to the machine works.

It may be noticed that our old 'A' dynamo had an uneven number of commutator bars which distinguished it from the 'Z,' 'L,' and 'K' dynamos that had an even number. It was when the Goerck Street Machine Works was about to start that Edison requested Clarke to design a dynamo like our Menlo Park one, but with an even number of commutator

bars and its capacity up to sixty 'A' lamps. This Clarke succeeded in doing, and worked out a rule for even and uneven commutator bars in connection with the Edison armature mode of winding.

Clarke left the Edison company on February 1, 1884, to try his fortune in other directions, which terminated when, as consulting engineer for the General Electric Company at the Schenectady works, he retired from active professional life in 1931. All his friends in the Edison company were staggered when they heard the news of his leaving, but he welcomed a change from the constant strain of the many diversified tasks to which he had attended day and night for a few years. Clarke was a pure Edison apostle, and his valuable and meritorious services to the Edisonian cause rank him as one of Edison's chief assistants who were, namely, Johnson, Batchelor, Upton, Kruesi, and Clarke.

The following personal notes from Edison to Clarke verify the fact that Edison always directed the work or experiments that were in progress:



Rec'd May 17. 1882

T. A. EDISON

Menlo Park, N. J., May 11 1882

Clarke;

Please send me result of Georges test of the several meters in series,

In testing the Cheese knife look out that when you have thrown several Carbons out that they got the EMF right that the Carbons dont gradually change their resistance necessitating another readjustment if this is so it will keep the regulator man very busy —

I should put Campbell or Soldan after he gets through with the C. 250 & 15 Light drawings on remodeling the whole street box system with an idea to Economy & convenience for the next Station as you say — Over

I think you will perhaps have to use Mercury & brush rigging Exactly similar to the C Dynamo on the 250 light, Do you not think it safe to go ahead on them. as the spark biz is a matter of brushes because ~~of the~~ the Commutator cannot be better & I understand the bobbin does not overheat etc Please give attention to this Dynamo it is very important in view of the Barden contract for lighting large mills My Impression is that Andrews ought to have an assistant fully

T. A. EDISON.

Menlo Park, N. J., 1881.

(2)

Competent to test machines, so that Andrews can pay more attention to the new & first machines hunting defects etc — I think you ought to see Maj Eaton About this =

Did you see the Jumbo run last night Dean writes that spark were nothing & that my conjecture verified what do you say to this

I advise renewing test lamp at Goerck st with new tips but only as fast as they break. be sure when you order of Upton to tell him where you use them & be very peremptory in requiring

over

the same kind of lamps
as before and to be absolutely
sure that they are 8½ per
hp & not 10 per h.p.
insist on this.

The Commutator speed of
the 250 is less than ⅓
more than the jumbo
hence I dont see why the
Current shouldnt be carried
easily if the area of
Contact is sufficient
I think the Mercury dodge
should be worked up on
these smaller machines
anyway if we do I am
sure we will get lots of
dodges to make it Convenient

T. A. EDISON.

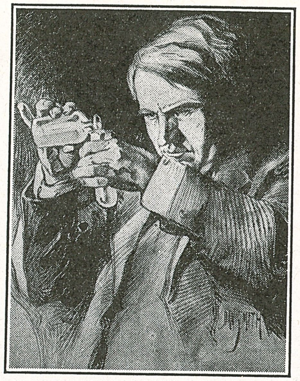
Menlo Park, N. J., 1881.

(3)

I should not order the
Cheese knife regs until I was
thoroughly satisfied by actual
test,

I should order the field reg
because I see no chance for
mistake there but please
carefully consider it with
a view of convenience;
and the absolutely impossibility
that connections in binding
posts or else where should
ever get loose. This is
of the greatest possible
importance as you can
imagine

T A Edison



THOMAS ALVA EDISON

From a drawing by Dan Smith, which was presented to The Edison Institute by Ralph H. Beach, who co-operated with the inventor in the early days in building a special type of streetcar operated by the Edison storage battery.

XCVIII More About the Goerck Street Shop

As I have said, those three years spent in introducing his new three-wire system were the most strenuous ones for Edison. Many intricate details required his daily attention, as there was only one man who could attend to them in principle, and he was Edison. He was always the first to notice what was wanted, and then to give orders to have his idea carried out. His great success in those days was due to the fact that he had men who rapidly understood what he wanted, and who likewise carried out his wishes.

Yes, Edison was alone initially responsible for all the basic fundamentals of his grand system of parallel distribution and the creation of his lamp and generators, with all the auxiliary equipment that was necessary. What he had accomplished was so great that it opened vast fields for secondary expansions and improvements, and all that followed from others in any part of his system emanated from the basic

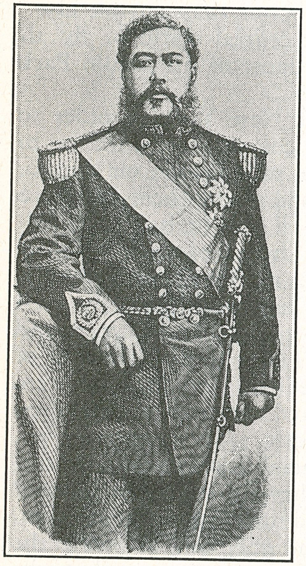
fundamental facts that he had worked out at Menlo Park. Yet, he was everywhere the sole, calm driving force and wedge who overcame all the obstacles that presented themselves during the time that he introduced his system and made such a success of it.

Edison's brilliant success was the outcome of three mighty efforts. The first was at Menlo Park where he created the practical lamp, a new and efficient generator, and other devices that completed his new system of parallel distribution. His second mighty effort was when he settled in New York City, and there had to organize, with his chosen apostles, the various technical offices, and to start the nucleus of a new industry that was destined to spread itself to every corner of the earth. His third and greatest effort was when he took matters personally into his hands and conducted the drive to demonstrate that his three-wire system was the last thing to convince many doubters that his system was now completed and was commercially feasible. In 1883, Edison said, 'I have come to the conclusion that my system of lighting, having been perfected, should be promoted, and that I can take hold and push the system better than anyone else.' He proved it by erecting a chain of central stations. In all these efforts Edison was assisted by most of his Menlo Park apostles here and in foreign countries.

Edison was often forced to leave New York in order to inspect some central station in the course of erection or to attend some celebration—in fact, he was always on the go. In Edison's mind, however, now and then, there began to surge some visions that he had done all that he had promised. In 1883, he had already begun to dream of days to come when he would devote all his energies to new things and wind up his electric-light affairs. Yet, he knew perfectly well that he was still tied down to his task for some years and that all depended upon him. We know that such ideas of his to quit at that period vanished as soon as they were uttered. Yet, he was tired and wanted a change, and he often intimated such thoughts in interviews. Then, he reflected, he had done his duty to his financial backers who owned all his patents. But what could they do with the patents? They still needed Edison to nurse and to rear the great system. As everything was new, he was the only one to create the industries and to manufacture the apparatus so that the system could be practically realized. Thus, he had to accept

new obligations and was tied down anew with tasks that were somewhat different from what he had expected. He had to become an engineer-promoter, and he succeeded in that far beyond expectations.

From early in the morning till late at night he was kept busy, and it may be said that outside of technical matters, there were also a host of so-called social duties. Distinguished visitors came to see him, many of whom he had to receive personally. He used to tell us about them when he came down to the Goerck Street works. Now and then he would mimic in voice and action a distinguished visitor whom he had received. I remember well the night when King Kalakaua, of the Sandwich Islands (now called Hawaiian Islands), came to pay Edison a visit at '65.' There was a flurry there, and I, having received a tip beforehand, was anxious to see a king, and, of course, did not miss the opportunity to go to headquarters. This happened in the latter part of September 1881.



His Majesty King Kalakaua, of the Sandwich Islands.

The Goerck Street works became more and more the meeting place at night where Edison whiled and there also received officials, visitors, and many of the bright young men who had entered the Edison service and who later became successful in the art and industry.

In writing my impressions of those days, it sometimes seems to me that I am too optimistic, but I must also admit that there existed a great deal of pessimism among many who still doubted the commercial success of Edison's system. Some were honest doubters; others were of the interested malicious kind. None was more malicious and sarcastic than Professor Morton, of the Stevens Institute of Technology. As one old-timer said,

Morton so ridiculed Edison and his subdivision that his audience was generally overcome with utmost hilarity. Morton, it was said, had been 'hired by the gas interests.' As an American, one wondered why a professor of an American institution of learning should take such an undignified course. From that same institution, two of our brightest men were graduated. I refer to John W. Lieb and John W. Howell. What they did to enhance the Edison system completely overshadows the flabby attempts that their tutor made to besmirch Edison and his work. It took some years before these sentiments were changed once and for all, although the Edison system was already functioning in almost every part of the globe.

What I am getting at is this: During the time those slanderous barrages appeared almost daily in certain newspapers or journals, Edison never for a moment lost faith or courage, but dared to continue in spite of the many annoying obstacles and incidents that often came up, but which he conquered. That is why I have said that those first years when he was introducing his system were the most strenuous years of his life, for his reputation and large sums of his money now hung in the balance—and all depended upon him. In the midst of the welter of those circumstances, he not only remained firm, but also was always the same old Edison—congenial and amiable.

Generally, when he went out-of-town he was accompanied by some of his old 'boys,' for he knew they could be relied upon if anything happened. When the lighting equipment was installed in the Bijou Theater, in Boston, Edison followed the work with special interest. The generating plant that supplied the current was installed in the basement of the printing office of Messrs. Cashman, Keating & Company on Washington Street, about 500 feet from the theater. It consisted of two Edison 'K' dynamos that were driven by an Armington & Sims engine and connected to the theater by Edison underground tubes. The whole outfit was, up to the end of 1882, the largest and best equipped isolated plant in the United States.

The theater had no other mode of illumination than the Edison incandescent lamp, and when the first formal performance was given in December 1882, it was attended by the governor and his staff in uniform, while Edison, Johnson, Bergmann, Clarke, Insull, Vail, Major Benton, S. B. Pain,

and others were all in formal evening dress. Everything went well until suddenly Edison noticed that the lights were gradually growing dimmer. He and Johnson hurried to the power plant and there found that while Vail was repairing a steam leak, the boilerman had neglected the boiler fire. Wondering why Edison did not return, some of his party followed and found Edison and Johnson with their swallow-tailed coats off and their high hats on a peg, busy shoveling coal into the firebox of the boiler. When the steam-pipe repairs were finished, they all went back to the theater and everything proceeded in good order.

In April 1883, General Diaz, ex-president of Mexico, came, with his wife and party, to pay a visit to Edison and was shown everything. Edison and Mrs. Mary Stilwell Edison received them, aided by F. S. Hastings, of the Edison company, and others. They went first to the house of fire engine No. 32 on John Street, one of the model engine houses in the city installed with Edison light and electric automatic arrangements. There they were entertained with fire-alarm exercises and General Diaz joined in the cheering that greeted the performances. The party later went to the Pearl Street Central Station, then to the Goerck Street works, and from there to Edison's provisional laboratory on the top floor of Bergmann's factory at Seventeenth Street and Avenue B, where Edison showed and explained many interesting problems on which he was working.

Advertisement of 'The Black Crook,' the sophistication of which shocked many matrons of the early '70's.

Yes, Edison did everything possible to show how flexible and practical his system was, and spared no pains in doing it.

The great showmen of those days were the Kiralfy Brothers. In 1874, they produced the much-talked-about ballet called 'The Black Crook,' which shocked the modesty of the fair sex of those days; however, that easily-shocked modesty has long since been sophisticated

through the new styles of dress for ladies. In 1883, the Kiralfy Brothers produced a similar spectacle called 'Excelsior,' which old-timers will remember was given at Niblo's Garden on Broadway, New York City. The Edison Electric Light Company had not yet extended its mains so far up Broadway as Niblo's Garden. Kiralfy Brothers got in touch with Edison and told him that they must have electric lights, to which Edison replied that the only possible way was to install a plant. The plant was ordered and Edison took personal charge of the whole affair. A 'K' generator wound for 55 volts and 500 eight-candle lamps was installed. Years later, Kiralfy told me that Edison took a keen interest in the work of the installation and supervised it in all details, giving special attention to the stage-effect manipulation. The theater program credited the novel lighting effects to The Edison Electric Light Company, under the personal direction of Mr. Thomas Edison.

Howard A. MacLean, who was transferred from the supply and shipping department on 97 Sixth Avenue to the Goerck Street works, once wrote in a letter to me that late one night in the early spring of 1884, Edison, Batchelor, Kruesi, and Russell (the private detective) all left the works, walked down Grand Street, and there took the horsecar to the west side of the city. Batchelor dared Edison to go out onto the front platform and to drive the car. Edison forgot business and took up the challenge. He went out to the driver, handed a quarter to him, and told him what he wanted to do. The driver handed the reins to Edison, and he drove several blocks, handling the hand brake and stopping and starting the car as if he were an old experienced driver. He enjoyed it and had the laugh on the rest of the 'boys.'

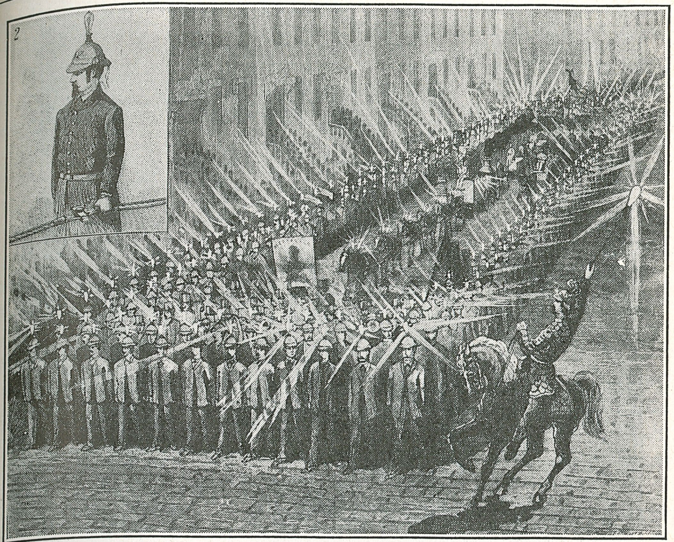
As Clarke told me, it was about 1883 that the rapid expansion of business took place. The growth of new departments with a number of new men changed the atmosphere of '65,' and the spirit of Menlo Park faded. The drafting room at '65' had been transferred to the Goerck Street works, and reconstruction of new models of Edison's dynamos commenced. At first, tryout models appeared, such as those used in the Brockton station, in Massachusetts, that began regular operation in October 1883.

I must not omit William H. Brenner, that Edisonian pioneer who also made his start in the Goerck Street testing room and later introduced the Edison system in Japan. He

erected the first central station in that country, and, like William Hortsek and a few others, formed that band of Edison men who planted the Edisonian standard in distant countries of the world.

In January 1884, the Edison Machine Works was incorporated with a capital stock of $200,000. Edison was the president; Batchelor, treasurer and general manager; Kruesi, assistant manager; and Insull, secretary. Batchelor, it may be mentioned, had just finished a most successful mission in France. He had built for the French Edison Company a lamp and machine works in Ivry-sur-Seine and had it in operating condition in August 1882. He, however, remained at the works for a year or so to insure its successful operation and to coach Monsieur R. V. Picou, a known engineer of those days, who had been intrusted by the French Edison Company to take over the general managership when Batchelor was scheduled to return home. When Batchelor arrived from Europe, he brought back plans of the Edison-Hopkinson dynamos and soon got things going for their manufacture in the Goerck Street shop. The old pioneer types were discontinued.

MacLean also mentioned to me some years ago that during the Blaine-Logan presidential campaign in 1884, he suggested to Batchelor and to Johnson the possibility of having an electrical exhibit, as a sort of advertisement, to form part of the Republican parade on October 13, 1884. Edison consented and the idea was staged and engineered by Batchelor, Kruesi, Johnson, Greenfield, and others. Current for the marchers was supplied by a mobile generating plant. An Edison 250-lamp generator was placed on a large truck where it was connected by a belt to a 40-horsepower steam engine. Steam was furnished by a large fire engine, which was connected to the steam engine by means of a flexible steam pipe. A long rope inclosed this generating plant and its auxiliaries, to which were attached wires conveying current to the helmets of the marchers. Conducting wires were connected to the connection blocks that were placed at regular intervals. Each parader had a flexible cord with a connector that ran up his sleeves and out at the collar to the lamp on the top of his helmet. By screwing the plug connector into the block, the lamp received the current. The parade took the New Yorkers by surprise, and astonished them.



The electric torchlight procession in New York City.

While Edison was attending to many things and especially following the erection of small central stations that he personally undertook to supervise, Batchelor and Kruesi were busy manufacturing the new series of standard dynamos and doing other work.

Edison's wife was not in good health, and we find that in April 1884, he spent a few weeks with her at the Magnolia Hotel at St. Augustine, Florida. I have already mentioned the fact that on August 9, 1884, his beloved wife, Mrs. Mary Stilwell Edison, passed away.

In October 1884, Edison set about to obtain a more willing board of directors in The Edison Electric Light Company—one that would further his ideas. If Edison had not been so sure of his system and the success that it would attain in time, he would never have taken recourse to institute a friendly purge so as to obtain a willing board of directors. It was life or death for him and his system. The Edison board of directors always held to the strict rules of business and did not want to accept orders where customers offered securities or notes (like some competitors who not only infringed his

Some of the Edison employes of the Goerck Street Machine Works in 1885: Left to right—Jim Carr, R. Lozier, H. MacLean, E. J. Berggren, W. Scott, J. R. Campbell, and W. M. McDougall.

lamp and system, but also, in order to do business, freely accepted notes until parts of the country were deluged with paper, and financial doctors were forced to perform a 'surgical' operation).

He also continued to spend time, whenever possible, at Bergmann's, where, outside of work on electric lighting, he began to experiment in improving his phonograph. The lawyers were always at his heels concerning patent suits that were in the process of being launched by the Edison company.

In the autumn of 1884, the Thomas A. Edison Construction Company ceased to function, and was merged into the Edison

company for isolated lighting; yet, the men who had been trained by Edison to erect and to operate his three-wire system continued to work for the isolated company and to erect many central stations. One thing my readers should keep in mind is that in those early days towns and cities did not have the populations that they have today. For instance, New York City had a population of about 950,000, Boston 260,000, Philadelphia 700,000, Detroit 80,000, San Francisco 150,000, and, of course, small towns were but villages. I mention this so that when reading of the central stations erected by Edison pioneers, one will not imagine large plants. New York City had only about 15,000 lamps in operation, while Sunbury, where the first three-wire system was put into operation by Edison himself, had only 500 lamps.(1) If we omit New York City, all the other stations in operation in 1884 ranged with a capacity of between 500 and 3,300 lamps. The growth since has been staggering; yet, don't forget that the light and the system were something new—yes, entirely new; nevertheless, what was done was phenomenal.

The Edison tube works was moved to 18 Bridge Street, Brooklyn, and there John Langton, Kruesi's trusted assistant, was made the superintendent. Different kinds of insulated wire, flexible cord, and so forth, had not yet been properly developed, although they were so necessary for installation wiring work that Edison decided to start such a new department in his Bridge Street annex in 1885. Here, those two master mechanics, Batchelor and Kruesi, exhibited the adaptability that had distinguished them in all their Edisonian activities. They evolved new wire machinery and commercially improved the art of producing different kinds of insulated wire and accessories, including cables.

I may say that with Batchelor's return, the gradual expansion of the Edison industries began. They were slowly shaped into standard conditions so as to be ready for any changes that might come up.

It was also in the beginning of 1885 that Edison began some experiments with what was called the Edison municipal system for street lighting. In this system, Edison had his lamp factory make lamps with rugged carbon filaments of low resistance that were operated in series. It was a multiple-series system, and one which persists today. It was designed for street lighting in towns and villages where many used oil,

(1) When lamps are designated, only those of sixteen-candle power are meant.

naphtha, and gasoline lamps. The tension employed was 1,200 volts, and lamps could more or less be put into series, depending upon their candle power. The lamps of different candle power required about three amperes and a tension of one volt per candle, while the generators varied in size from twelve to forty-eight amperes at a tension of 1,200 volts. These street lamps were screwed into sockets and protected by a reflector hood. In this hood there was an apparatus that closed the circuit when a lamp broke, thus keeping the continuity of the circuit.

Later, a special lamp was devised through which the lamp became short-circuited when its filament broke. Each circuit passed through an ammeter and a lamp-resistance board. Thus, a station attendant could see when a street lamp broke, for then the current indicated an increase at the ammeter. The attendant then plugged in a lamp and brought the circuit back to its normal strength. When the broken street lamp was replaced with a good one, the station attendant noticed it at the ammeter and plugged out the lamp at the board. The system was ingenious, and was a welcome addition to central stations, enabling them to light streets beyond the limits of their three-wire systems or to light streets where their mains had not yet been placed. These special lamps for the Edison municipal system were made to give fifteen, twenty, twenty-five, thirty, forty, and fifty candle power. As they consumed about three amperes and one volt per candle, we see that the fifty-candle lamps could have twenty-four such lamps in series on a circuit, while the twenty-five-candle lamps could have forty-eight of them in series in another circuit; all circuits, however, consumed about 3,600 watts each.

The generators were of the same type as those that Batchelor was manufacturing in the Goerck Street works, only, of course, the armature and field magnet coils were wound accordingly. Bergmann & Company made the central-station cutout boards used in each circuit, and the Edison Lamp Works made the lamps.

I must mention that when G. Soldan took Dean's place as superintendent of the Goerck Street works, he, in turn, was succeeded by William McDougall, who followed the works when it moved to Schenectady, but stayed there only a short time.

I may also mention that at the Electrical Exhibition held

in Boston during the early part of 1885, Edison was a frequent visitor and was often seen in company with Mr. Ezra T. Gilliland. It was said that due to Edison and Gilliland the exhibition became a success. Gilliland and Edison had met in the early days in the Louisville, Kentucky, telegraph office where both were engaged as telegraph operators. It was at the Gilliland home in Boston that Edison met Miss Mina Miller, of Akron, Ohio, who later became his wife. Edison associated himself with Gilliland in some experiments pertaining to telegraphing from moving trains. Some of these were made at the Edison laboratory in Bergmann's factory. Some years later Edison placed Gilliland in connection with his Edison Phonograph Works, and there Gilliland committed an act that ruptured their friendly relations. Part of the work Batchelor was doing in the Goerck Street works in 1885 was the construction of a passenger car with Edison electric motors for the elevated road in New York City.

Office force at 104 Goerck Street: Left to right—Theodore Van Deventer, Robert Lozier, Quinn, Howard MacLean, General Manager Batchelor, John Campbell, Superintendent McDougall, and Ernest Berggren (from an old print).

In the summer of 1885, Edison and his daughter, Dot, stayed in Boston for a couple of weeks. It was a sort of vacation that was partly business; yet, we have evidence that Edison was a changed man from those days on, an Edison who was thinking often of other matters than experiments. He well knew that his industries were properly taken care of. The machine works was under the able direction of Batchelor and Kruesi; the lamp works was taken care of by Upton; while the Bergmann works was still under the direction of Bergmann. They were all well-seasoned men and old-timers who had assisted Edison years before 65 Fifth Avenue was ever thought of. With the aid of these men, Edison knew he was now more free than at any other time since he began the work of introducing his electric-light system. He was about to begin a new life, deviating gradually and slowly from the business routine of electric lighting, although retaining an interest and readiness to give advice when necessary. In his laboratory at the Bergmann works, he started his loyal bodyguard assistant, John Ott, on a series of phonographic experiments and made improvements that he had not seriously attempted since 1878.

There was something significant in the fact that in the beginning of February 1886, Edison bought a palatial residence at West Orange, New Jersey, and at the same time ordered material for a building in Maine, with the understanding that when the wood was cut it be packed and placed on a schooner to be delivered at Fort Myers, Florida. Edison, it was said, went down south himself to superintend the erection of the building that became his winter laboratory.(2)

In the middle of February 1886, the curiosity of many was satisfied when the newspapers announced the engagement of Mr. Thomas A. Edison and Miss Mina Miller, and that the engagement was consummated on a visit of Mr. Edison's to Akron, Ohio, about six weeks previously. It was also mentioned that Mr. Edison had first met Miss Mina Miller at the Gilliland home in Boston during February 1885, and that the acquaintanceship was fostered by a meeting at the Chautauqua Assembly the previous summer.

Miss Miller was an attractive brunette, twenty years of age, who was graduated from a Boston seminary in 1884. Her accomplishments, together with her rare social graces,

(2) Today, we find it in Greenfield Village in Dearborn, Michigan, having been donated by the great inventor to Mr. Henry Ford.

made her a favorite far beyond the circles of her home town, Akron, Ohio. After being graduated from the seminary, she made a tour of Europe. Lewis Miller, her father, was the son of John Miller, who was of German descent. Lewis put the family name on the map. He became a distinguished inventor, educator, and philanthropist—in fact, he was a self-made man who had worked his way up from the bottom. In 1855, he invented the Buckeye Mower, and it is said that he took out more than 100 patents. Gradually he acquired large factories in Canton and Akron. He was also known for his organizing abilities and was prominent in many educational religious undertakings. In 1873, he was made one of the incorporators of the Chautauqua movement, and became president of the Chautauqua Assembly. He possessed determination and was a tireless worker. It is said that Edison described him as having 'spent his life trying to make it possible for all mankind to reach the higher planes of living,' and he seemed to be eternally making money in his factories in order to enable him to better carry on his schemes for education.

CHAS. A. BATCHELOR,
taken in Paris, France.

XCIX. The Edison Machine Works

COMING back again to the Edison Machine Works on Goerck Street, New York, it may be mentioned that those two versatile, untiring, and fine expert mechanics, Batchelor and Kruesi, made a most brilliant showing in bringing out a set of ten standard new-type Edison dynamos that ranged in capacity from twenty-five to 500 sixteen-candle-power lamps of the bamboo-carbon filaments.(1)

These types of generators were manufactured for the two- and three-wire systems, as well as for the municipal system; in fact, orders were taken for any current and voltage as well as for shunt or compound field windings. I know they also made dynamos of very large current and small voltage, used in copper deposition works. The machine

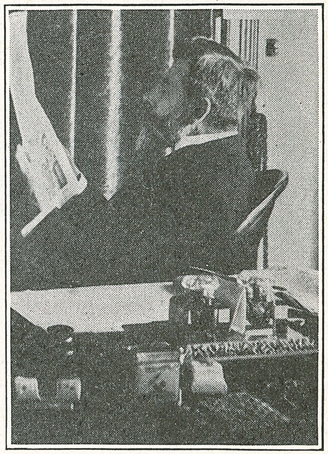
(1) The sizes were for twenty-five, fifty, seventy-five, 100, 150, 200, 250, 300, 400, and 500 sixteen-candle-power lamps.

works also manufactured all those other heavy adjuncts and accessories necessary in installing large electric isolated plants and also for central-station work.

A part of the Goerck Street works toward the north end was enlarged; that is, that part consisted only of the ground floor, and three floors were built over it. Yet, it was soon found that the works was cramped for space. Later, in a consultation with Edison, it was decided to erect shops on a block in Brooklyn, and an architect was engaged to draw the plans.

Then in June 1886, the men at the 104 Goerck Street works, as well as those at 18-24 Bridge Street, Brooklyn, presented to Treasurer and General Manager Batchelor a set of demands that, after being considered, was rejected. The result was a strike. This happened just at the time when the Edison Machine Works had some contracts with our Government in connection with an order for three torpedo boats, and also some important work for several central stations. Edison, Batchelor, and Kruesi held another meeting, reconsidered the matter, and a compromise with the men was made so that all returned to work. The situation, however, was reconsidered afterward. Because similar labor disturbances came up so frequently in large cities, it was decided to move both works out of town as soon as possible.

Not long afterward an acceptable location was found in Schenectady, New York, by Henry M. Livor who had charge of the supply and shipping departments of the works, at that time situated at 97 Sixth Avenue, New York City. The property that Mr. Livor found was that of a new concern that had intended to go into competition with a locomotive works. It was called the McQueens locomotive works and failed before operations were started, going into bank-



JOHN KRUESI,
taken by his son Paul Kruesi in their Schenectady home.

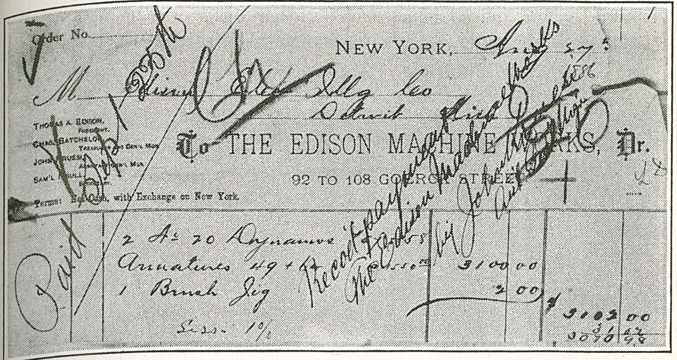
ruptcy. Batchelor and Kruesi went to Schenectady to examine the buildings and found them suitable in every way. They immediately got in touch with Mr. de Remer who was the receiver of the property, and it was not long afterward that the Edison Machine Works had the title to the deed.

Work was then started in order to get the two large shops equipped and in running order. I might say that the shops were about 300 feet long and 120 feet wide; the whole property covered a tract of about thirteen acres. Several steam engines, large and small, were installed, and among them were two Brown steam engines, one of which was the one that we had formerly used at Menlo Park in all the work there. This same engine also furnished the power for the first historic demonstration of Edison's system of electric lighting in 1879.

Before the removal of the Goerck Street shop, it happened that on September 25, 1886, The Edison Illuminating Company of Detroit, Michigan, which was organized on April 15, 1886, paid two bills for four No. 20 Edison dynamos that had been delivered to them.(2) This was the company where Mr. Henry Ford first found a job, in 1891, in the electrical line, and where also Mr. Alex Dow became general manager and vice-president of the company in 1896. Now, what is interesting about the bills and what I wish to point out is that they show 'who was who' in the Edison Machine Works. We see from the bills that Edison was president; Batchelor, treasurer and gen-

Charles Batchelor (left) and Luther Stieringer at the Edison Machine Works, Schenectady, New York.

(2) These Edison generators were each designated as a No. 20 and had a capacity of 500 sixteen-candle-power lamps



Order No.

NEW YORK,

To THE EDISON MACHINE WORKS, Dr.

92 TO 108 GOERCK STREET

Terms: with Exchange on New York.

2 No. 20 Dynamos

Armatures

1 Brush Jig

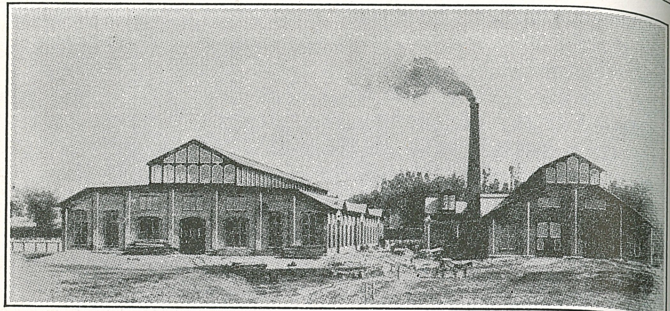
3100 00

3103 00

This bill shows 'who was who' in the Edison Machine Works, and also shows the price of an Edison dynamo for 500 lamps of the carbon-bamboo filament, sixteen-candle type.

eral manager; Kruesi, assistant general manager; and Insull, secretary. Although, at this period, Edison only made flying inspections to his works, he remained, nevertheless, ever the inspirational director of all the works that he controlled, and his ideas were always faithfully carried out by Batchelor and Kruesi. Yes, in building up and extending the machine works on Goerck Street as well as the one on Bridge Street, Brooklyn, and the one in Schenectady, I might say that it was Batchelor and Kruesi who attended to all the negotiations; Insull took care of the secretarial work. All did their share; yet, outside of Edison, it was Batchelor and Kruesi who did the bossing and not only managed the Goerck Street and Bridge Street shops but also, when they moved to Schenectady, did the same there, until the end of 1887.

By the above, I have meant to point out and to emphasize that at that time, or rather in any other period, Insull was never the financial genius of Edison as some flatterers styled him years afterward. These 'some' were persons who, in most cases, had no knowledge of how matters stood; but there were those who knew better. Let me here remind the readers, as mentioned in Volume I of *Menlo Park Reminiscences*, of the story of Grosvenor P. Lowrey who visioned the capabilities of Edison after he had invented the phonograph and who thought that Edison could solve the problem of electric

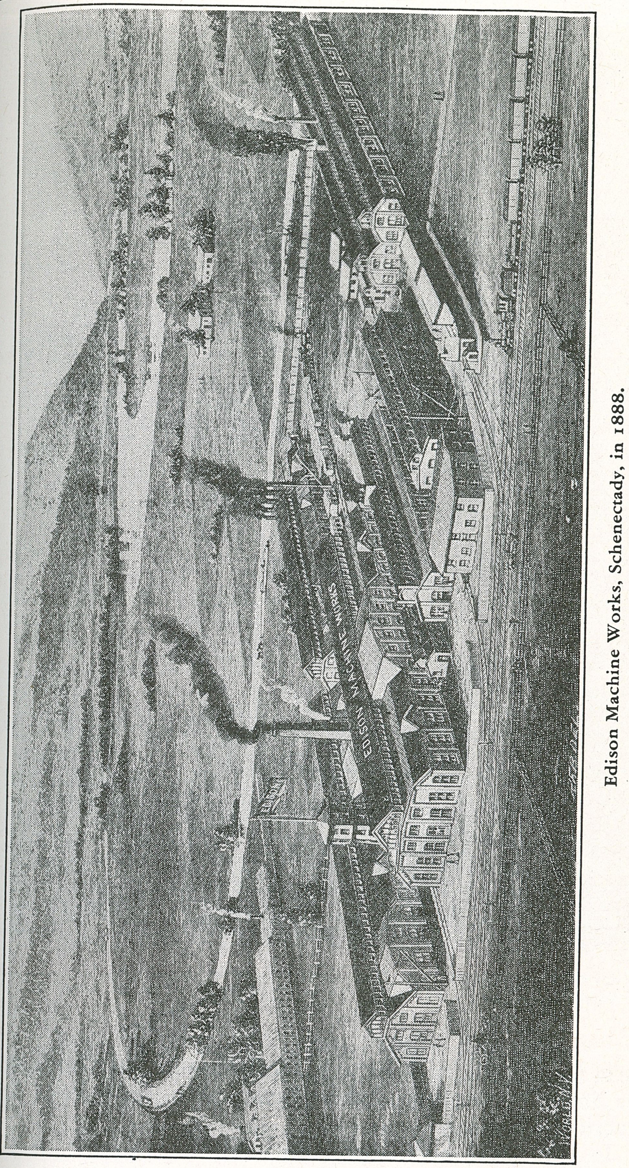


The McQueen locomotive works as it appeared in 1886 when Thomas A. Edison established the Edison Machine Works (from an old print).

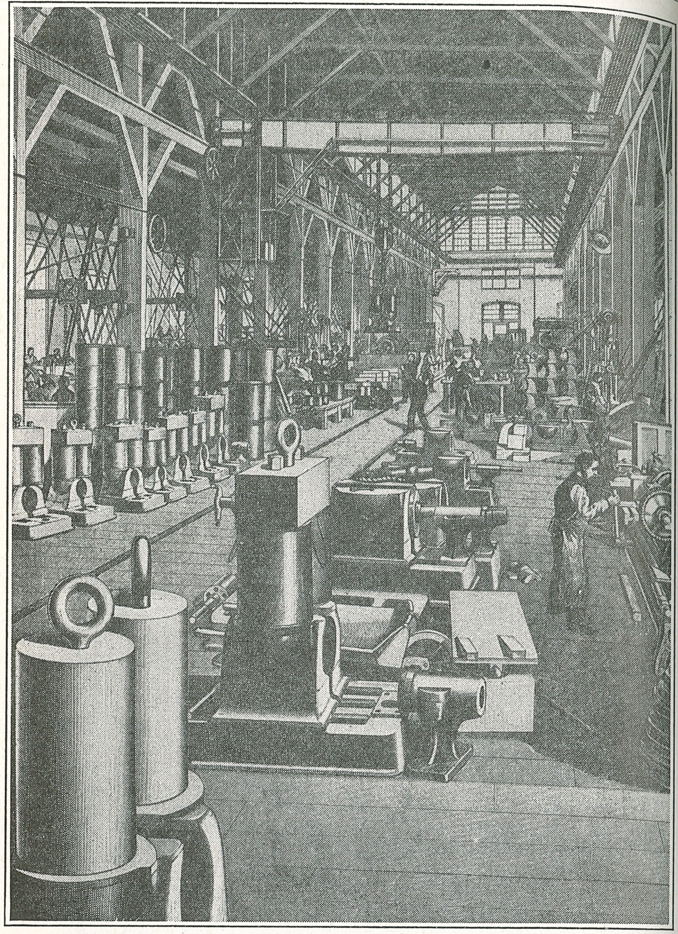
all was thus set for Villard's coming merger. For one year Insull was treasurer and general business manager of the Edison Machine Works—that was during 1888. In April 1889, the Edison Electric Light Company, the Edison Machine Works, the Edison Lamp Works, Bergmann & Company, Edison United Manufacturing Company, Sprague Electric Railroad and Motor Company, and the Canadian Edison Manufacturing Company were consolidated, and the combined interests of all of the companies were merged into one called the Edison General Electric Company which, as I have already mentioned, was headed by Henry Villard.

With the creation of the Edison General Electric Company, the Edison Machine Works and the other companies, all of which Edison had founded and built up, passed out of existence. The new combination was conducted under the aggressive Villard, and Insull thus had a new boss from whom he, no doubt, learned much. Insull became second vice-president and general manager, while Kruesi went over to the new company and was its assistant general manager.

Thus ends the story of the last undertaking that Edison had created. The first was the Edison Lamp Works; the second, the partnership with Bergmann; and the third, the Edison Machine Works. With the products of these works, the new art of illumination came into being; and when he sold out to Villard, he had brought it so far forward that others could take it over and advance it further as time went on and as progress dictated. He (Edison) I say, laid down the



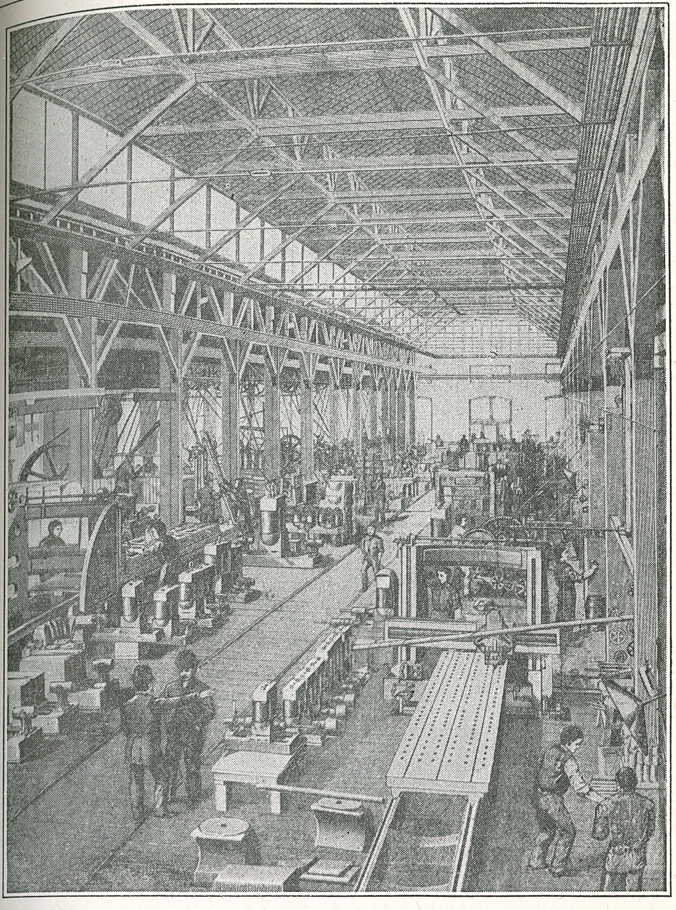
Edison Machine Works, Schenectady, in 1888.



View of the central aisle, southern half of No. 2 machine shop, Edison Machine Works, Schenectady, showing the area for assemblage of dynamos (from *Electrical World*).

basic foundation of all the practical tenets that have solved the art of generating electric light, heat, and power for all practical purposes.

In December 1888, the *Electrical World* already informed



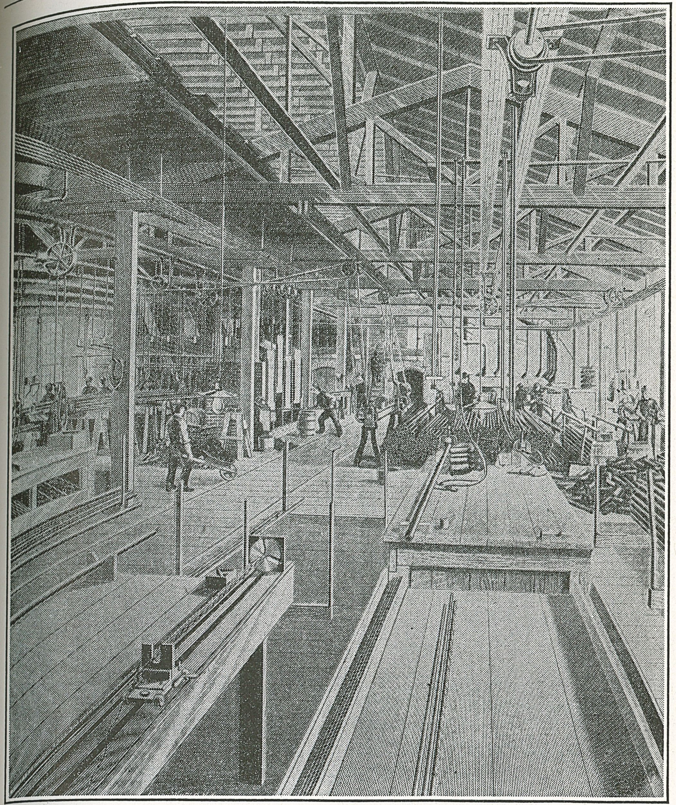
Central aisle, northern half of No. 2 machine shop, Edison Machine Works, Schenectady (from *Electrical World*).

the public as follows: 'For some months past reports have been current in well-informed electrical circles as to an intention to bring the various Edison lighting and manufacturing interests together in one large corporation and under one central management. It would be very difficult to keep such

Portion of the armature winding department, Edison Machine Works, Schenectady (from *Electrical World*).

important plans wholly secret, and we need not be surprised, therefore, to see that the newspapers have devoted space to the matter, especially as the rumors connect with it so well known a name as that of Mr. Henry Villard, and involve a capitalization of $12,000,000.'

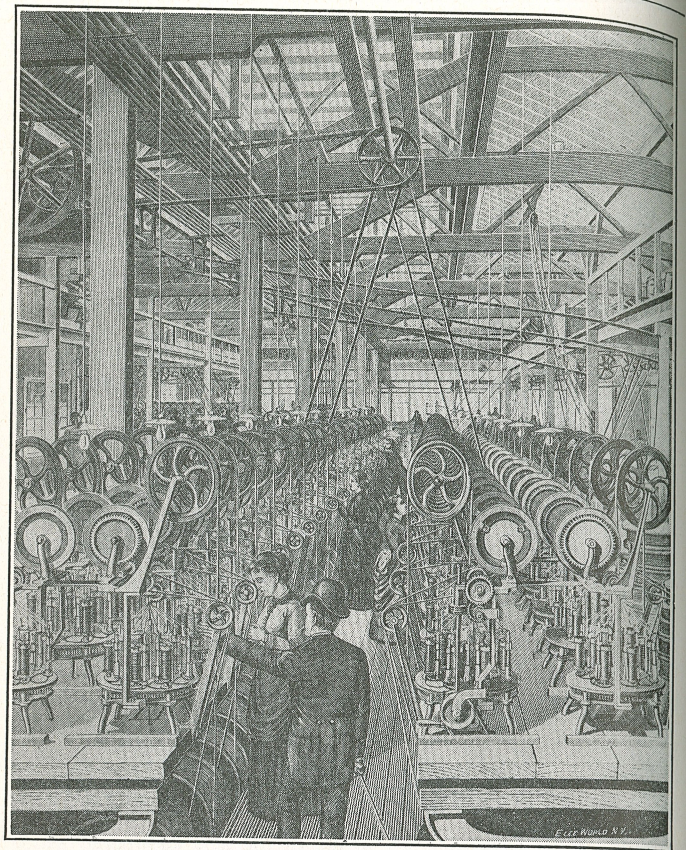
We must not forget that Villard, some months before the above notice was published, had been in Europe and had interested German capital, among which was the firm of Siemens and Halske, pioneers in electricity.



Making underground conductors in the electric tube department, Edison Machine Works, Schenectady (from *Electrical World*).

All this confirms what I have often mentioned about Edison—that already in 1886 he was in earnest to get out and that Batchelor and Kruesi helped him to put the Schenectady works in order for the purpose.

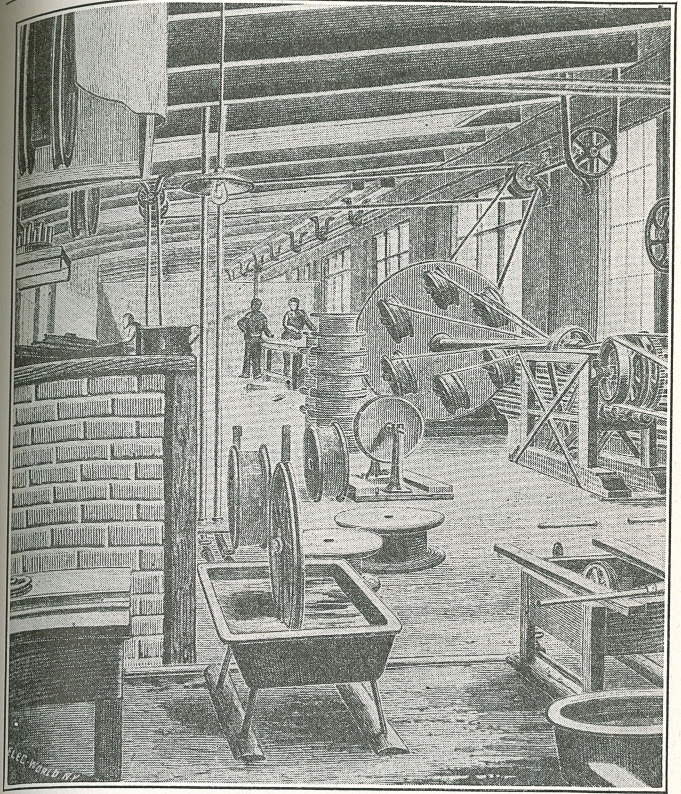
What was done, however, was phenomenal, for the magnitude of the work was enough to inspire all. For their work, these two veterans, Batchelor and Kruesi, should surely deserve the blue ribbon of the Edisonian art at that period.



View of the main floor of the wire insulating department, No. 1 shop, Edison Machine Works, Schenectady (from *Electrical World*).

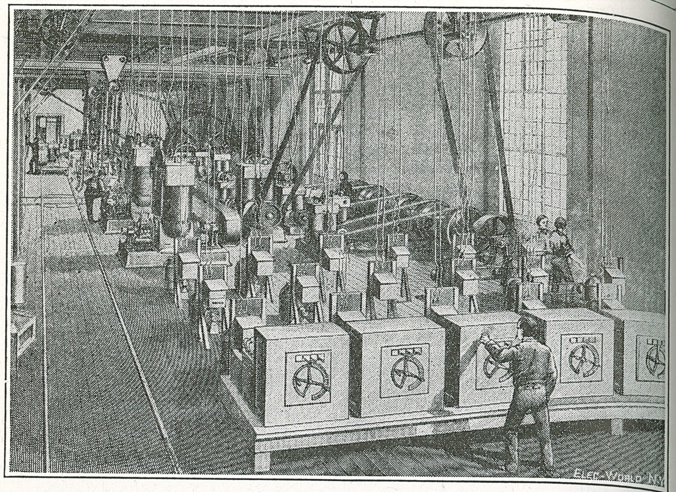
I will now give a pictorial review(3) of how Edison, assisted by Batchelor and Kruesi, built up the Edison Machine Works in Schenectady and made it ready for the general merger of all the Edison industries, thus giving him his long desired release.

(3) The illustrations are taken from the *Electrical World* and, connected with the article written in this supplement, were the first advanced inference of what was soon going to take place.

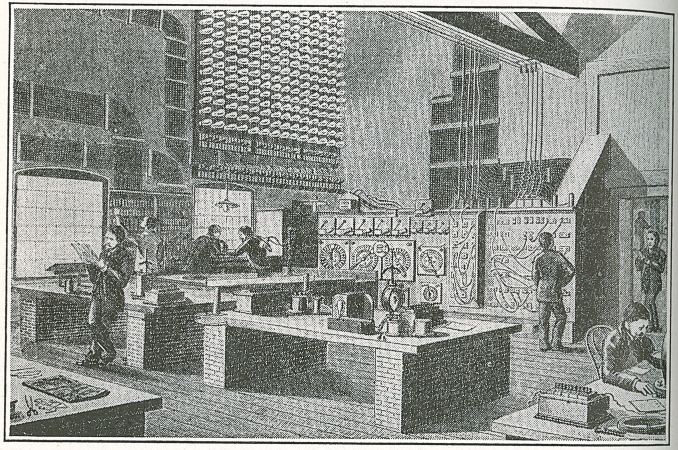


Stranding department for large cables, Edison Machine Works, Schenectady (from *Electrical World*).

In reading over the matter so far written, I see that the names of some of the men who once took part in the work then going on on Goerck Street and on Bridge Street are missing. One was George G. Grower, who assisted me in 1881 in the testing room. Then Nikola Tesla at one time was in the Goerck Street Edison Machine Works testing room. He asked Batchelor for a raise but it was refused; so he soon left. Now it happened that Batchelor and I knew Tesla well when we were at Ivry-sur-Seine, just outside of Paris.



Dynamo and motor testing department, Edison Machine Works, Schenectady (from *Electrical World*).



Switchboard and instrument testing department, Edison Machine Works, Schenectady (from *Electrical World*).

Batchelor was fitting up the machine and lamp works there for the French Edison Company. One day a tall lanky young man came out to the factory and handed in a letter from Karl Puskas, Budapest, Hungary. This Puskas was the brother of Theodore Puskas who was the agent for Edison's system in Europe, excepting England. Our agent had already acquainted Batchelor with the facts and asked to have the young man trained so that he could be employed to do outside work in installing the Edison system.

We—that is, my old friend Etienne de Fodor(4) and I —soon found out that the young man's name was Nikola Tesla and that he had been employed in Budapest with Karl Puskas who was the manager of one of the first telephone systems in Europe. We learned that Tesla was a Croatian and that he had studied in the technical high school in Gratz, Austria. He used to tell us what a grand thing it would be if one could use alternating current and have motors without commutators. We told him we thought so also, but that he should use his brains now in getting all information possible about the Edison system, and then get to work. We also learned that Tesla was a dreamer and that he had a surprising, carnivorous appetite, and he could generally be brought out of his dreams by the smell of a juicy steak of the Chateaubriand kind. Often De Fodor, Tesla, and I lunched at a small French restaurant near our works called Forge de Ivry. Tesla, now and then, would be so hungry that he would have his order repeated.

Then it happened that the installation of the large railroad station in Strasbourg (Alsace, Germany,) came into question, where De Fodor, Martin Force, and Philip Seuble had already made a demonstration with a sixty-lamp dynamo. Tesla had an aversion to running wires or making installations, and it did not suit him when he was sent to Strasbourg to assist in the work there. Up to that time Tesla was used to those congenial conditions that were in vogue in Austria-Hungary, the motto being 'If I don't come today, I come tomorrow.' Then again, after lunch one would go into the cafe, take a cup of black coffee, and have a game of billiards or a rubber of cards. In the evening, one went to a beerhouse, or winehouse, and discussed daily matters with others as they sipped their drinks. They were all good-

(4) Etienne de Fodor was associated with the Edison interests in Paris, France, in 1881, and did eminent Edison work all his life in Europe from that time on.

natured and lighthearted people who did not take life too seriously. Tesla did not like the American activity that Batchelor had brought into the French Edison Works there and when he—that is, Tesla—came there, the place had not the lure for him that he thought an Edison place would have.

De Fodor was working meanwhile in Russia, and he was not surprised when he received an order from Paris to hasten to report in Strasbourg. It turned out that the German officials who were used to discipline complained to the Paris office that Tesla passed the beautiful golden morning time, when he ought to have watched the work, in the arms of Morpheus. Tesla came back to Paris but had no desire to return to Ivry-sur-Seine. He asked Batchelor to help him get to America and to get him a job at Edison's. Batchelor made it clear to him that there was not much hope for him at the Edison Machine Works after what had happened. I was told that Puskas intervened, and that Tesla, nevertheless, reached America and Goerck Street.

Batchelor's work being finished, he returned home and took over the general managership of the Edison Machine Works.

The above little episode explains why Batchelor did not give a raise to Tesla; and as Tate(5) relates in his work, Batchelor said: 'The woods are full of men like him; I can get any number of them I want for $18 a week.'

We all know how Tesla metamorphosed, for he succeeded later in making an alternating motor, of which he used to dream while at Ivry-sur-Seine.

There, in the old Goerck Street machine shop's testing room, was also Henry E. Walters who later in Schenectady was calculating the dynamos. When Edward E. Winters joined the Edison interests in 1886, he assisted Walters in the testing room and was said to be a skillful hand. Winters also assisted Montgomery Waddell as electrician when the latter was chief of the laying of Edison's underground conductors. Johnson (not E. H.) was foreman of the gangs that assisted Waddell. Al Harkson was the foreman of the armature winders. He was succeeded by C. W. Jefferson, who was head of the insulating department. In 1892, he founded a firm that manufactured electric insulating varnishes, micanite, tapes, and so on. When I was still in Europe, one of the 'boys' wrote that the engineering staff changed often in

(5) *Edison's Open Door*, by Alfred O. Tate.

Engineering staff of the Edison Machine Works, Schenectady, 1889: Left to right—Third from left, H. F. J. Erben; fifth, Mr. Milner; sixth, J. Mac Haffie; seventh, William Danco; ninth, G. H. Rupley; tenth (derby hat) Mr. Burlingham; eleventh, Dr. Emil Kolben; twelfth, Mr. Fritak; thirteenth, A. E. Wiener; and third from right, W. S. Clark. (Others are not known.)

Schenectady, for it was then only a town of 10,000 inhabitants and life was too dull for many there at that period.

Langton and Walters left, while Waddell with Entz formed a partnership that became well-known later on. No wonder that, when Insull was made general manager of the works in 1888, Schenectady was much too tame for him and that he spent most of his time in the New York office at 19 Dey Street. I remember it was said that the contact with the works in Schenectady and the general office in New York City was often difficult. I was informed on good authority that Edison begged for information on what was going on in Schenectady—how busy they were—and added that 'While I am still on the Board, I don't know anything.'

There were also Wallace S. Clark and Phillips who had charge of the wire and cable department. Winters tells of an amusing incident that happened when Phillips demonstrated a fireproof cord he had invented before a party of insurance men. The test was made with 110 volts while the cord was placed on a table with an iron block under the cord. Phillips, with a hatchet raised, was waiting the word or signal from

Toastmaster, - E. J. BERGGREN.

F. A. Phelps, Jr., H. F. J. Erben,
Wm. Danco, F. Bathurst,
A. E. Wiener, A. Churchill,
G. H. Rupley, J. S. Hodges,
R. Milne, J. W. Lucas,
G. Faure, J. Soderberg,
T. E. Button, J. Reckenzaun,
Wm. Thomae, O. Junggren.
C. G. Hulth.

E. J. Berggren, S. D. Slocum,
P. Weber, C. H. Kaler,
H. N. Marvin, W. S. Clarke,
C. F. Hild, J. Dancer,
W. G. Rothwell, F. Mueller,
D. O. Youlen, D. Mason,
R. G. Brooke, A. H. Wilkle,
C. W. Jefferson. G. Tailleur.

INVITED • GUESTS.

Mr. John Kruesl. Mr. W. E. Gilmore.
Mr. W. B. Turner.

Names of the outstanding men with the Edison General Electric Company who attended the 'Au Revoir' supper given for Dr. Emil Kolben at the Edison Hotel, Schenectady, on June 27, 1891.

Kruesi. When he gave it, down came the hatchet—result: cord in flames and general fireworks. Winters said that soon after Phillips disappeared and Clark took his place.

One of the well-known figures at the Edison Machine Works in Schenectady was W. B. Turner, generally called 'Pop' Turner. He was superintendent and was well-liked by his men.

Among some of the real old-timers were Ernest J. Berggren, J. F. Madgett, Charles F. Peterson, Daniel C. Campbell, John T. H. Dempster, and others, among whom we may mention George C. Reilley, Justine B. Entz, Henry Geisenhoner, Edwin Place, August F. Tinnerholm, Carl H. Wilson, Wallace S. Clark, Byron T. Burt, Robert A. Carter, William D. MacQuesten, William F. Dress, Bryce E. Morrow, Daniel Dodd, Peter Weber, H. F. J. Erben, E. B. Raymond, John Mac Haffie, James Burke, Edward A. Stevenson, William S. Barstow, F. J. Odell, Edward E. Platts, John Diehl, Dr. Emil Kolben, and no doubt some others whom I have missed.

With the end of the Edison Machine Works in Schenectady, the real Edison pioneers ceased, but a new class of pioneers began with Villard's combine, the Edison General Electric Company. These pioneers and those who came over from

MENU

Puree de Tomato—Croutons.

Baked Bluefish, au Gratin.
Pomme de Terre, Francaise.

Roast Ribs of Prime Beef, Dish Gravy.
Mashed Potatoes. *Sliced Tomatoes.*
New Peas.

Roast Young Turkey, Stuffed, Cranberry Sauce.
Stringless Beans. *Sliced Cucumbers.*
Sweet Corn.

Filet of Beef Larded, aux Champignons.
Potato Croquettes. *Sugar Beets in Sauce.*

Roman Punch.

Lobster Salad, en Mayonaise.

Strawberry Ice Cream.
Oranges. *Bananas.*
Angel Cake. *Fruit Cake.* *Pound Cake.*
Crackers. *Cheese.*
French Coffee.

Menu of the 'Au Revoir' supper tendered to Dr. Emil Kolben, chief engineer, on June 27, 1891.

the Edison Machine Works had new problems to encounter and to work out. These were the men who now had occasion to work along the line of progress as it came up and as it advanced with new innovations, such as multipolar generators and other appliances. Still they were shy, as yet, of the alternating-current system, although they had the patent rights for the same.(6) Then came, in 1892, the merger that the bankers effected, and the General Electric Company came into being. Conservativeness vanished and improvements of every kind found their place.

My work, however, ended with that of the Edison Machine Works. I wish to say that many of the bright young men who once were employed there succeeded in their life careers far beyond the general average. Interesting is a letter that I once received from Dr. Emil Kolben who was engaged by Kruesi in August 1888. Kolben was an academic electrical engineer who had studied at the University of Prague. When he started work in Schenectady, his pay was $16 a week. There were about 650 men engaged there at the time. Kruesi placed him in the octagonal wooden water tower that had a large water tank on its top. The drawing office was there,

(6) See p. 832, Vol. II, and p. 953, Vol. III, *Menlo Park Reminiscences*.

Names.

MANAGEMENT.

JOHN KRUESI.	W. E. GILMORE,	W. B. TURNER.
	AUG. WEBER.	

GENERAL OFFICE.

E. J. BERGGREN,	A. LUNDGREN.	JOS. INSULL,
C. E. STEVENS,	H. L. BALTOZER,	L. O. WEBER,
T. A. BRANION.	T. N. MURRAY,	J. R. SCHERMERHORN,
D. B. LYON,	J. T. WASSON,	G. S. BEYER.

ENGINEERING DEPARTMENT AND DRAFTING ROOM.

F. A. PHELPS,	H. F. PARSHALL,	W. DANCO,
H. F. ERBEN,	M. D. LAW,	F. BATHURST,
A. CHURCHILL,	H. N. MARVIN,	A. E. WIENER,
H. HUGHES,	G. FAURE,	J. BURKE,
H. CRONKHITE	J. S. HODGES,	A. B. HERRICK,
H. P. BALL,	R. I. MILNE,	J. MAC HAFFIE,
J. RECKENZAUN,	J. W. LUCAS,	A. GORANSON,
A. JONSSON,	J. LODERBERG,	F. STERN,
C. F. HULTH,	H. RUPLEY,	O. JUNGGREN.

FOREMEN.

PETER WEBER,	D. O. YOULEN,	C. W. JEFFERSON,
W. S. CLARK,	A. METZGER,	R. G. BROOKE,
C. S. MOORE,	T. GUNN,	W. MADIGAN,
R. J. RUSSELL,	J. C. DANCER,	C. H. HILD,
C. GRANNEMAN,	C. PURK,	A. SMITH,
G. ROTHWELL,	H. WILSON,	C. H. KALER,
W. J. MORRIS,	W. E. VAN PATTEN,	GUSTAV KORNETZKE.
H. LELAND,	H. PILLING.	

TESTING ROOM.

D. DODD, JR.,	A. H. WILKIE,	B. E. MORROW,
M. H. JOHNSON,	L. S. HANSEN,	C. F. ROBINSON,
W. H. GRAEF,	G. S. MANSFIELD,	R. C. SWAYZE.
	PAUL WERTHEIM.	

Names of men from different departments of the Edison General Electric Company who honored Chief Engineer Kolben with a farewell supper when he left for Europe. It was given at the Barhydt House, Schenectady, on February 3, 1892. The toastmaster was E. J. Berggren. The menu was just as plentiful as that of the earlier banquet of June 27, 1891.

and sometimes it happened that the automatic device, which at night had to control the water level, would not function, and the whole drawing office would become flooded, damaging drawings, tracings, and so on. Also, the level of the ground on which the works was situated was only a little above the level of the Mohawk River, so that in the springtime at high water the whole ground of the works, including all the floors of the shop, would be overrun with water, causing great general damage.

Kolben's first job was to design a No. 32 dynamo. In the Summer of 1889, the new direction (Edison General Electric Company) handed a check to Kolben for $1,000 and

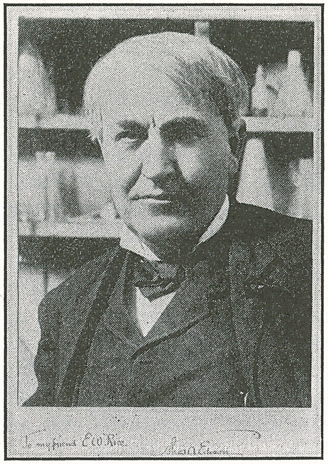
sent him to the Paris exposition to see what was new there in electrical engineering. When he returned in October, Edison requested Kruesi to let Kolben come to Orange for a while, as he wanted him to work out some theoretical calculation in connection with an electrically driven streetcar. When he returned to Schenectady, Kruesi placed Kolben in charge of the whole mechanical and electrical engineering work as chief engineer. When he left in 1892 for Europe, he handed over his duties to his successor H. F. Parshall.

Kolben also told me that when he came to Schenectady, Batchelor had already left. Yet, his name was often mentioned, as was the good work he had done there.

When Kolben went to the Frankfort exhibition in June 1891, he was given an 'Au Revoir' supper, and it is interesting to note the names of most of the principal employes who were there then. When I gaze at the bill of fare given at that supper, I am always reminded of Tesla and how he would have relished such a spread at the time he was with us at Ivry-sur-Seine, France.

When Kolben left for Europe in 1892, he was again given a parting supper and the names of the men who took part then are also shown. Kruesi presented Kolben, when he left, with a large photograph album showing how the works had expanded since Villard had placed all the Edison industries together. It may be mentioned that at that time about 4,500 men were employed.

The push of Villard had put in order all that was necessary for the finishing touch that soon followed; that is, the birth of the General Electric Company.



Photograph of Thomas Alva Edison, autographed, 'To my friend E. W. Rice.'

C. The Pearl Street Central Station

(PART ONE)

IT WAS Edison who first conceived, originated, and built a central station for the supply of electric energy for all purposes. The Edison Electric Light Company was the first company ever organized to supply current for domestic purposes, using the parallel system of distribution at a constant pressure and employing incandescent lamps.

E. W. Rice, Jr.,(1) once put it tersely when he said:

'In the three years between 1879 and 1882, Edison invented, developed, and worked out the principles and details of a comprehensive system of generation, control, distribution, measurement, and utilization of electrical energy for public use on a large scale.

'Viewed from the standpoint of today after a lapse of

(1) See Vol. II, p. 841.

forty years [now nearly sixty years], Edison's achievements of that early period appear almost miraculous. They have stood the test of the most extensive and intensive technical development of the electrical industry.

'His system of distribution of electrical energy on the multiple or parallel plan has survived and is the only method by which an unlimited amount of electrical energy can be generated and distributed over an unlimited area in a practical and commercial manner.'

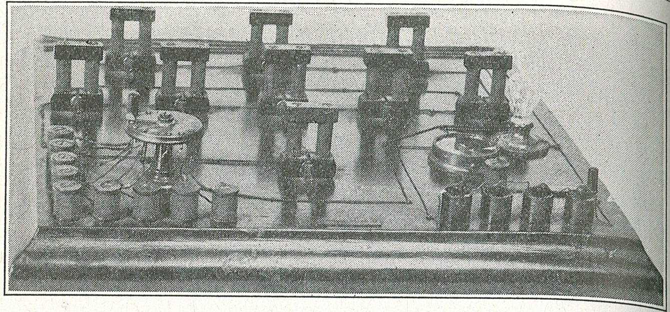
At Menlo Park in New Jersey, Edison first demonstrated his system in an experimental way in December 1879, and some months in 1880. The little central station consisted of only three Edison 'A' dynamos, and had a capacity of about 100-120 sixteen-candle, paper-horseshoe, carbon incandescent lamps.(2)

The system of distribution was an overhead, two-wire one that lighted the Edison compound and the few residences at Menlo Park. Many thousands of visitors came there from all parts of America and Europe and wondered at what they saw. The telegraph, cables, and newspapers heralded Edison's great achievements. This was, and happened, before any pirate here or in Europe had the arrogant cheek to question the greatness of what was going on at Menlo Park, New Jersey. The New York *Herald*, of Sunday, December 21, 1879, 'let the cat out of the bag' before Edison desired it, with a whole page of descriptive matter. What was now seen at Menlo Park was a reality: Edison dynamos were running, Edison incandescent lamps were brightly glowing in the houses of Menlo Park, and the Edison parallel system was in operation.

I mention this because before December 1879, yes, already in September 1878, Edison told newspapermen that nature's vast water power would be utilized; and from that time on newspaper editors kept a constant eye on Menlo Park. Not a week passed without interviews with Edison being quoted, concerning the possibilities of using electrical energy for light, heat, and power.

As already mentioned, The Edison Electric Light Company was incorporated under the laws of the State of New York on October 15, 1878, and that company furnished Edison with the means to conduct experiments on a large scale. Their

(2) This station can now be seen at the Edison machine shop in Menlo Park, Greenfield Village, Dearborn, Michigan. See also Vol. II, p. 488.



Patent model of Edison's system of electrical distribution, No. 369,280. Patent applied for February 5, 1880. It contained the fundamental principles of current supply, field excitation, current regulation, and measurements on the multiple-arc principle.

success was amply demonstrated during the first trial over a period of several months. The second Menlo Park demonstration took place during the winter months of 1880-81, and was on a more extensive scale, with ten Edison sixty-lamp generators and one exciter dynamo. In this station Edison employed the first lamps having bamboo filaments. The distribution of current was effected with underground conductors. During the demonstrations, Charles L. Clarke made an economy test in presence of engineers, and it was proved that the practical and commercial success of Edison's system was assured. That test meant that the period of introduction was soon to follow. Clarke left Menlo Park on February 7, 1881, while Kruesi followed within a week.

At the Edison headquarters at 65 Fifth Avenue, Edison and Clarke began the task of planning the world's first commercial electric supply station. Edison, meanwhile, was searching for a site for his central station—a most embarrassing job. He found real estate priced so high around the spot he had selected as the best and most economical for his station, that he had to abandon the location. Thinking that in the slums district he might find a much cheaper piece of property, he toured some of the streets near the water front—that is, near the East River. He found that at 255 and 257 Pearl Street two buildings were up for sale. One had twenty-five feet of frontage and was eighty feet deep, and the other was twenty-five feet by a hundred feet; the price asked for both was $155,000.

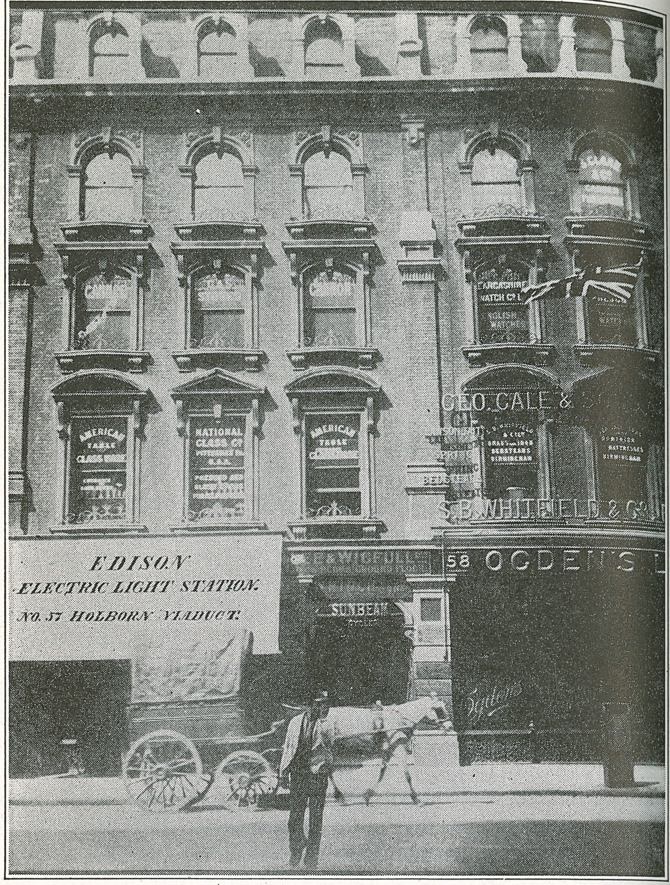
The high price forced Edison to change his plans and to build the first central station of structural iron work, on different floors.

Before describing the first station—which was finished and went into operation on September 4, 1882—I will describe what had been done in the station line before the first real commercial station went into operation. That Pearl Street Central Station was built to stay; it was erected by academic engineers.

After E. H. Johnson had organized the Edison Telephone Company in London, England, at 11 Queen Victoria Street, he returned home, only to be sent back at the beginning of 1880. Edison did this to start the English Edison Electric Light Company, and for that purpose Johnson first took over some of the Edison paper-horseshoe lamps, and had Dr. J. A. Fleming demonstrate them with battery current to English notables in the basement of the Edison Telephone Company on Queen Victoria Street. Fleming, in his book,(3) says: '*They were shown to many people.*' It was the first time that the English had been shown a filament lamp of *high resistance*, and *one that had life*. Fleming also says in his book: 'Edison had carefully worked out before 1882 all the details of a complete system for the public supply of electric energy.' Johnson was also instructed by Edison to demonstrate to the English public the Edison system of central-station current delivery. For this purpose, Johnson rented a space at 57 Holborn Viaduct, and there the largest exhibition central station ever shown was set up and equipped by the Edison Electric Light Company of New York at that time.

William J. Hammer, one of our Menlo Park 'boys', was sent over to assist Johnson as electrician, while John Hood, our steam engineer, and Jim Holloway, one of our mechanics, helped to install and to mount the Jumbo generators. There was also H. C. Patterson, one of Kruesi's men, who placed the Edison underground conductors, mains, and feeders in position. Jumbo No. 2 was finished at the Goerck Street works toward the end of 1881 and then sent to London where Hood soon had it mounted. He started it on January 12, 1882. When Jumbo No. 3 arrived, it was coupled with

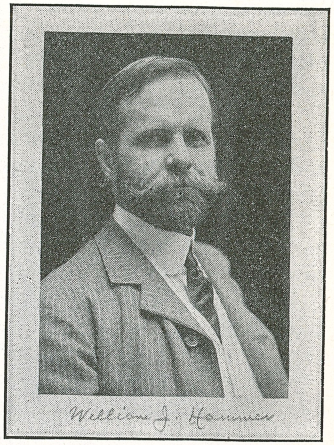
(3) Fleming also shows in his book an illustration of Swan's so-called original carbon-rod electric lamp, 1878. The writer, who has passed through those periods, never saw such a lamp at that time, and neither the English *Engineering* nor James Dredge in his book can show such a lamp. It seems impossible to believe that Dredge would not have shown the lamp in his books instead of showing the one he does, and which I have shown in Vol. II, p. 472, cut 7.



No. 57 Holborn Viaduct, London, England, where the trial Edison central station was erected in the basement in 1882.

No. 2 in parallel on April 11, and both operated together successfully. It may be mentioned that Jumbo No. 2 was driven by a Porter-Allen steam engine and Jumbo No. 3, by an Armington & Sims steam engine.

Late in 1883, a third Jumbo was added, which brought the station's capacity up to more than 3,000 sixteen-candle lamps.



WILLIAM J. HAMMER

Prior to April 22, 1882, Hammer's men had already installed 938 lamps. They lighted certain residences, stores, churches, streets, post offices, and so on, and the current was registered by Edison's meters, while regular service had already started on April 11, 1882. The tests of the whole system and station plant were made by Fleming and Hopkinson, who were electrical advisers to the English Edison Electric Light Company.

I may mention that besides the three Jumbos installed, there was also a 'K' type Edison dynamo having a capacity of 250 sixteen-candle lamps, which was belt-driven by an Armington & Sims engine. This small plant supplied current for such consumers as needed light during the daytime. The experimental central station gave satisfaction in every way, and the remarkable performances of Hammer and Hood were exemplary and served the Edison cause in England well. I can add that they did their duties conscientiously and faithfully.

It is not necessary to mention that Johnson also finished his obligations with success and needs no praise, for he could always take care of himself.

The station continued to operate until the beginning of 1884; it was then dismantled, having served its purpose.

As I have mentioned several times in my first two books, Edison sent me to England. My mission was to demonstrate the Edison electrolytic meter, and I brought the first samples to England and Continental Europe. I left New York on February 22, 1882, and arrived in Liverpool in March. The English Edison Electric Light Company had its offices at 74 Coleman Street, and, after having presented myself there, I was requested by Mr. Arnold White, secretary of the company, to bring an Edison meter(4) next day to 57 Holborn

(4) See Vol. II, p. 655—also London *Electrician* of May 20, 1882, and of June 3, 1882.

Viaduct. When I came, I found Dr. Fleming and Dr. J. Hopkinson there. I explained to them all about the Edison meter. Some meters were then placed at consumers' stores, and the practical tests proved that they were accurate.

Professor R. E. Day, lecturer in physics at Kings College, London, asked me to loan a meter to him, and before a crowded and interested assembly lectured on it in the college auditorium.

I wish to note that while the Holborn station was in the course of erection, Hammer was also supervising the installation of the Edison exhibit at the Crystal Palace Electric Exposition at Sydenham. For that exhibit Edison sent twelve 'Z' type Edison dynamos. It was opened in the early part of 1882 and ran until sometime in June of the same year.

Toward the end of 1883, Hammer was sent to Berlin, Germany, to assist the German Edison Company. He remained there about a year, and returned to America in the fall of 1884.

I left London on June 9, 1882, for Paris, and the following letter that I wrote to Clarke is interesting in some respects:

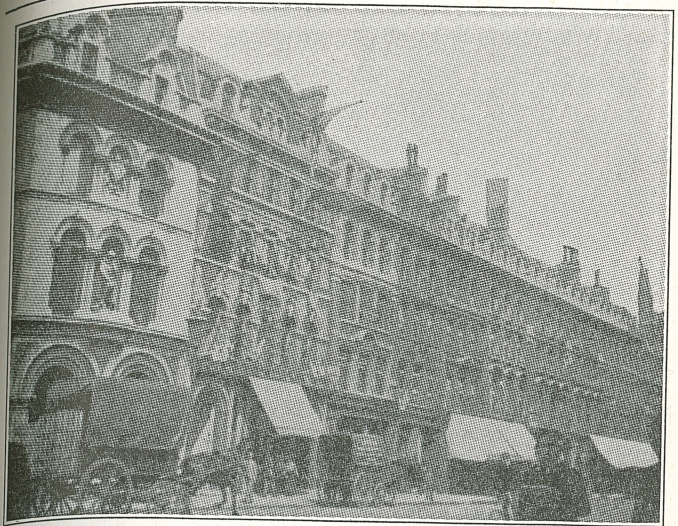
The Edison Electric Light Company, Ltd.,
74 Coleman Street,
London, E. C.,
June 8, 1882.

My dear Clarke:

I have just received your letter bearing date of May 29 and hasten to reply, as I have made all my arrangements for leaving London tomorrow evening for Paris.

I consider my mission here finished; the young man whom this company gave to me to instruct in regard to meters understands them now, and we have them in operation on the viaduct. They work well and give satisfaction. There is one thing, however, that the consumers do not like, and that is the taking away of the deposited plate and weighing it at the station. What they would like to see, or to have, is something that will produce visible indications, such as a dial and so on. You know this is an age when even a Sunday school superintendent is not believed.

You speak, or rather state, that many changes have been made in the meter since I left. I received a short note from George the other day, not giving any details, merely stating the change made in the solution, with a curve of the changes due to a variation of temperature in the deposition cell. These facts I have confirmed by experiment, and inclosed you will find a chart showing the variation and the formula under such circumstances. I have also added a curve showing the variations in a circuit consisting of the compensation resistance and the deposition cell. You will see that there is not much variation between five and thirty-five degrees centigrade, and that the average resistance is about 8.317 ohms. I hope that you will, as soon as possible, give to me all the information relating to the changes you have made in the meter and send a model of one to me. Please give details and so on. I wrote some time ago for a drawing of our small dynamo—I mean the armature connections. Will you please send it, together with the ones of the new machines —the 100, 250, and other light ones?

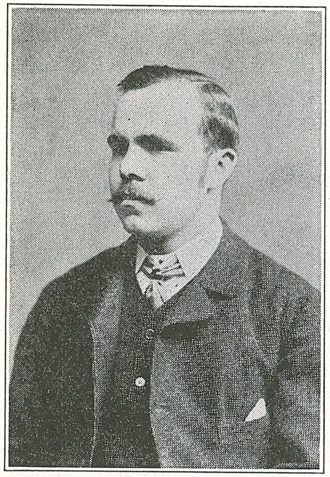


View showing one side of the buildings on a part of Holborn Viaduct, 1882.

These requests I merely make for the advancement of Mr. Edison's interests; for by the time I receive the information, such machines will, no doubt, be in circulation over here, and if an accident should happen to an armature, it would save a great amount of trouble and time if such drawings were here.

I would also be pleased to learn all the new obstacles that have developed in any part of the system since I left and the precautions taken to obviate the same. I cannot impress upon you the amount of good such information does and how much it helps to advance our object and aims. There is intense excitement prevailing at present in Europe regarding electric lighting, and the one great cause that seems to hold back the system, or rather, I might say, prevents its rapid distribution, is the lack of competent men. For instance, if anything goes wrong, only an Edisonian man can remedy it. But then, of course (the thing being new), in time such defects will cease to exist.

Over here in England there is a new company started almost every week, and every Tom, Dick, and Harry has what he calls a new incandescent light, on the strength of which he starts a new company, and if he makes any money, he skips out, leaving the shareholders in the dark. The Holborn Viaduct plant works very well, and it runs every night—so far not having any serious accidents, except the one that happened some time ago. At present, the men in this plant are making a test, the object of which is to ascertain the amount of coal burnt and the amount of water consumed, thus finding out what it costs to run the plant and what should be charged. This is a question that I



FRANCIS JEHL, when he was in London in 1882.

wish you would answer; namely, what does the New York company propose to charge a weber?(5) This question is asked almost every day and as it is an optional one, the company alone can answer it. It depends, of course, upon location, but I would like to know what the New York company will charge.

Johnson, I believe, will leave England next week for America; so will you please have all letters addressed to me at the Paris office. I have sent to you a small book on electric lighting, which has just come out and which I wish you would accept from me. Crystal Palace is closed now. If it is within my power in any way to aid you with anything over here, I shall be most happy to do so, if you will let me know.

What is going on at Menlo Park? I have heard that Edison is there again. Is there anything besides the railway? Oh! I wish I were there again, and I cannot tell at present when my return can be looked for.

Hoping that Mrs. Clarke is well and that you are succeeding, I remain

Yours sincerely,
Francis Jehl

P. S.—Give my best wishes to all the folks.

To C. L. Clarke, Esq.,
65 Fifth Avenue,
New York City.

A small Edison central station was started in Fall River, Massachusetts, in March 1882. This miniature central station had a capacity of about 120 'A' lamps, and the two dynamos were located about 400 feet away. It lighted several stores that were located in two blocks. The Seventh Bulletin of The Edison Electric Light Company of April 17, 1882, describes fully this little central station.

The French Edison Company installed an interesting experimental central station in Besancon in August 1882, and it was started on September 1, 1882. Interesting, also, is the fact that this station was driven by water power;(6) Besancon is situated about 260 miles from Paris and is almost

(5) The weber is a unit of current.

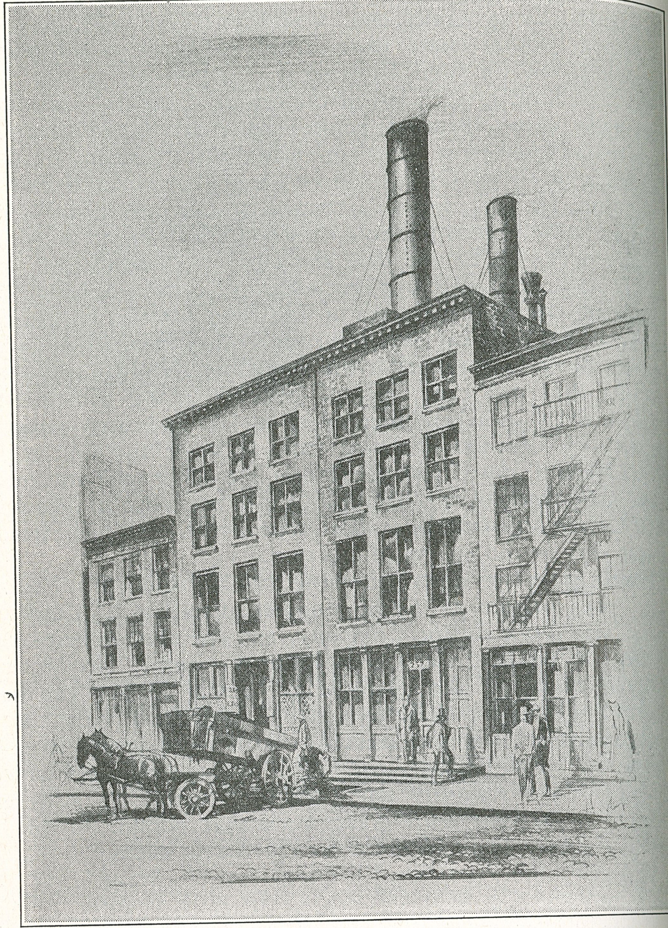
(6) The first Edison plant that was driven by water power was installed by the French Edison Company in Steyr, Austria. The plant consisted of a 'Z' type Edison generator and began operation in June 1882. Additional Edison dynamos were soon installed. The plant lighted the large Austrian Arms Work.

surrounded by the River Doubs. The plant consisted of three Edison 'Z' dynamos and the current was conveyed by overhead wires almost a mile from town. The lines passed through a 1,250-foot-long tunnel that was lighted by thirty-seven 'A' lamps. Other lamps were distributed in private houses and stores, and for street lighting.

So far I have given a list of the few trial central stations that went into operation before the Pearl Street Central Station was finished in New York City. I wish to emphasize that none of these stations can be compared with the Pearl Street one, for they were all erected in a circuslike fashion and none was destined to stay; they were trial, or exhibition, stations only. It is true that the Holborn Viaduct station was the most elaborate one erected, and Edison succeeded in convincing the most stubborn of Englishmen that his system was not only practical but also commercially feasible. Yet, it must not be forgotten that the Pearl Street station was the first one that was ever designed on engineering principles; it was erected in a permanent way to last and was studied carefully by engineers. These facts make it the first real central station, notwithstanding that the other trial stations I have mentioned were mushroomed into existence to demonstrate Edison's system for a short time while the Pearl Street station was in the course of erection.(7)

I will give two descriptions of this historic central station: one written by Chief Engineer Charles L. Clarke, of the New York Edison Company, and one that came from the pen of its first electrician John W. Lieb. No better historical report of the Pearl Street Central Station can be found anywhere, for these two men, like Edison, were part of that station as it was erected. Both were academic engineers and loyal Edison men. Both of these pioneers were noted for their assiduity and good judgment; they were intrusted by Edison with great work that became history, and they amply justified the trust reposed in them.

(7) For a long while it was said that the Edison plant at Appleton, Wisconsin, was the first central station, and was started August 15, 1882. This was proved to be an error, for, upon investigating the back files of the local newspapers, it was found that the Appleton station was started on September 30, 1882.



The Pearl Street Central Station in 1882. The building at 257 housed the generators and all the accessory equipment, while the offices and storehouses were at 255.

CI. The Pearl Street Central Station

(PART TWO)

The Historic Pearl Street New York Edison Station

BY THE FIRST CHIEF ENGINEER OF THE NEW YORK EDISON COMPANY
[Mr. Charles L. Clarke]

A reprint from Edisonia *published in 1904 by the Association of Edison Illuminating Companies*

IN THE fall of 1881 plans had been practically perfected by Mr. Edison for the installation on a large scale, for the Edison Electric Illuminating Company, New York City, of the first permanent commercial incandescent electric lighting and power system embodying the many main and accessory features of construction and operation that he had invented and laboriously perfected, and deemed essential to make electric lighting a successful competitor with the large gas lighting plants in cities.

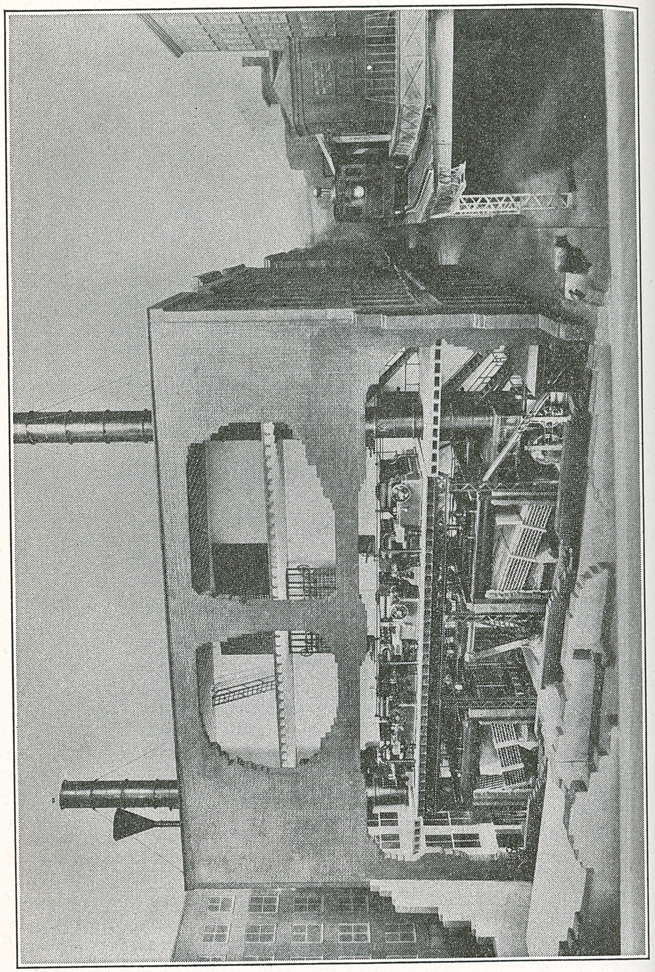
The district selected for lighting was the area—nearly a square mile in extent—included between Wall, Nassau, Spruce and Ferry Streets, Peck Slip and the East River; and the property, 255 and 257 Pearl Street, was purchased as the site for the central station generating plant.

The laying of the underground system of conductors in the streets (which was a 2-wire, so-called 'feeder-and-main,' system, as described in U. S. Patent 264,642); the wiring of buildings for the lamps, and the work of constructing foundations, erecting the iron structure for supporting the generators on the second floor, setting up of the Babcock & Wilcox boilers and accessories in the building, 257 Pearl Street, preparatory to the installation of six 'Jumbo' generators, were commenced in the fall of 1881, and were in an advanced stage of completion in April, 1882.

In July, the laying of the underground conductors, aggregating over 80,000 lineal feet of mains and feeders, was practically completed. The installation of the 'Jumbos' (Nos. 4 to 9 inclusive, which were at first run by Porter-Allen engines) was completed in June. On June 29 fire was started under the boilers. On July 5 one of the 'Jumbos' was started, and on July 8, it was tested upon a bank of 1,000 lamps located in the upper story of the station.

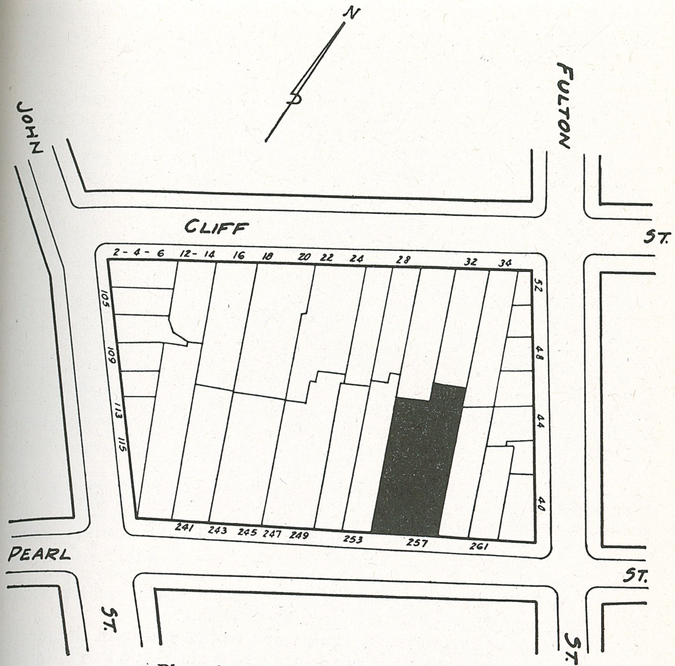
The station was started in commercial operation on Monday, September 4, 1882, at 3 P. M., with a load of about 400 lamps, supplied with current through the underground conductors by 'Jumbo' No. 9. This machine was the one nearest to the Pearl Street front of the station. Among the customers first supplied with light was the firm of Drexel & Morgan, corner Broad and Nassau Streets, at the outermost limits of the system.

Everything operated so smoothly at the start that it seemed as if the long, hard labor of Mr. Edison was to be rewarded at once with complete success. But in a few minutes a serious trouble arose, which at first seemed fatal to his plans, and temporarily was very discouraging. After 'Jumbo' No. 9 had been running a short time, a second machine was started and connected with the bus-bars in multiple arc with No. 9. Immediately the two machines began to 'hunt,' the engine governors first cutting off and then giving full



View of the world's first central station erected by Thomas A. Edison on Pearl Street, New York City, in 1881-82. The elevated passed the station, opposite was the United States Hotel, and the shadow of the Brooklyn Bridge is seen in the distance. The New York Edison Company donated a model of the station to the Edison historical collection in Dearborn.

—*Courtesy of the Deutsches Museum, Munich, Germany.*

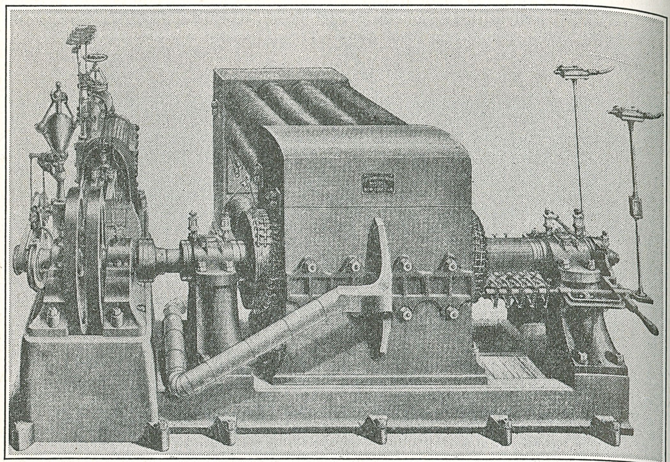


Plan of Pearl Street, where station was.

steam admission, and causing the machines to alternately seesaw between standstill and a terrific rate of speed. The second machine was at once disconnected from the line and stopped. And for some time the station was operated with only one machine.

Dash-pots were applied to the governors with no practical success. Finally, Mr. Edison overcame the difficulty for the time being, and the machines were operated in multiple, by means of a complicated system of pivoted rods, levers and shafting, as described in patent 271,616, by which the governors of all the engines at any time in operation were mechanically connected together, so that the tendency of any governor to control its engine was communicated to the governors of all the other engines. The shafting was made light, and yet with comparatively great torsional rigidity, which was essential to prevent lost motion in the action of one governor upon another, by constructing it of tubing with a central rod, the tube and rod being first pinned together at one end, then twisted in opposite directions at the other end, and there pinned together in the twisted positions.

In November, 1882, two 'Jumbos,' driven by Armington & Sims engines, each controlled independently by its own governor, were successfully operated in multiple arc at the Edison Machine Works. And, as a result of this experiment, the Porter-Allen engines were removed from the Pearl Street Station,



Jumbo No. 9—the dynamo that supplied the first current to the public. This was the only dynamo that was saved when fire ravaged the station in 1890. Jumbo No. 9 was first connected with a Porter-Allen engine as shown. It was presented by the New York Edison Company to the Edison historical collection in Dearborn.

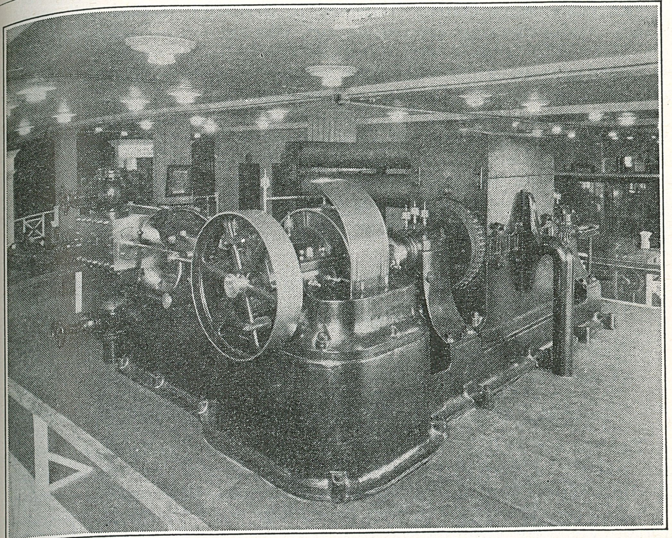
and Armington & Sims engines substituted in place of them, and the necessity of tying the governors together was done away with.[1]

The excellency of the materials, design and workmanship in the machines were signally demonstrated by an endurance test made in the Pearl Street Station, where a 'Jumbo,' driven by an Armington & Sims engine, and in normal commercial operation, ran continuously day and night for seventeen days, from March 10, to 27, 1883. Inspection after the test showed not the slightest wear or need of readjustment in any part of the machine.

The number of lamps connected with the system, and customers supplied, gradually increased. On December 1, 1883, there were in use 10,297 lamps on the premises of 513 customers. The district was also extended, and toward the end of 1883 the underground system comprised about 95,000 lineal feet of mains and feeders. Electric motors were first connected with the system to furnish power on customers' premises in 1884.

(1) In the Holborn Viaduct Station the difficulty of 'hunting' was not experienced. At the time the 'Jumbos' were first operated in multiple arc, April 8, 1882, one machine was driven by a Porter-Allen engine, and the other by an Armington & Sims engine, and both machines were on a solid foundation. At the station at Milan, Italy, the first 'Jumbos' operated in multiple arc were driven by Porter-Allen engines, and dash-pots were applied to the governors. These machines were also upon a solid foundation, and no trouble was experienced.

At the Pearl Street Station, however, the machines were supported upon long iron floor beams, and at the high speed of 350 revolutions per minute, considerable vertical vibration was given to the engines. And the writer is inclined to the opinion that this vibration, acting in the same direction as the action of gravitation, which was one of the two controlling forces in the operation of the Porter-Allen governor, was the primary cause of the 'hunting.' In the Armington & Sims engine the controlling forces in the operation of the governor were the centrifugal force of revolving weights and the opposing force of compressed springs, and neither the action of gravitation nor the vertical vibrations of the engine could have any sensible effect upon the governor.



When Edison found, in 1882, that the Armington & Sims engine suited him better for coupling the Jumbos in parallel, he replaced the Porter-Allen engines with the former toward the end of 1882. Cut shows Jumbo No. 9 with the Armington & Sims engine.

Customers were not charged for lighting until the system was working smoothly and satisfactorily in every respect. The first bill for lighting, based upon the reading of the Edison electrolytic meter, with which the system was equipped, and amounting to $50.40, was collected, January 18, 1883, from the Ansonia Brass & Copper Company, 17 and 19 Cliff Street. During the month of November, 1883, a little over one year after the station was started, bills for lighting, amounting to $9,102.45, were collected.

In the spring of 1884, the capacity of the station was increased by installing two additional 'Jumbos' in the basement of 255 Pearl Street.

There was considerable sparking at the copper commutator brushes of the 'Jumbo,' due to the odd number of commutator bars, necessitated by the form of armature winding employed, and also to the comparatively small number of bars and the dissymmetrical disposition of the magnetic field with relation to the armature. In the early operation of the Pearl Street Station, which, it should be remembered, was before the days of carbon brushes, an effort was made to suppress the sparking and accompanying wear of brushes and cutting of the commutator surface, by a liberal application of mercury thereto, and with some success. But the sparking was nevertheless sufficient to fill the air with mercury fumes, which so badly salivated the attendants that the method had to be abandoned, and thereafter a careful adjustment of the brushes and attention to their condition and to the surface of the commutator were relied upon to minimize its harmful effects. The commutator bars were provided with copper plates, or shoes, as wearing surfaces, which could be readily replaced when worn out.

The Pearl Street Station continued in successful, commercial operation until Thursday morning, January 2, 1890, when it was partially destroyed by fire. All of the 'Jumbos' were ruined, excepting No. 9, which, on account of its installation on a fire-proof floor and at the front of the building, was covered up and saved. The boilers were unharmed.

Belt-driven generators and engines were quickly installed, and the station was again in operation in a few days, and the uninjured 'Jumbo' No. 9 again continued to perform its duty. But the glory of the old Pearl Street Station, unique in bearing the impress of Mr. Edison's personality, and, as it were, constructed with his own hands, disappeared in the flame and smoke of that Thursday morning fire.

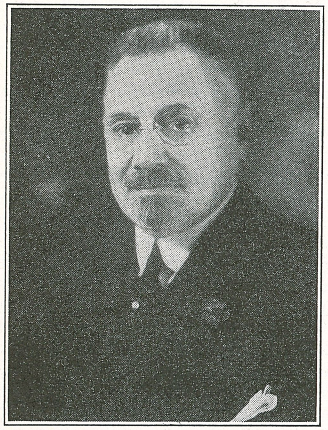
The Historic Pearl Street New York Edison Station

BY THE FIRST ELECTRICIAN OF THE STATION
[Mr. John W. Lieb]

A reprint from Edisonia *published in 1904 by the Association of Edison Illuminating Companies*

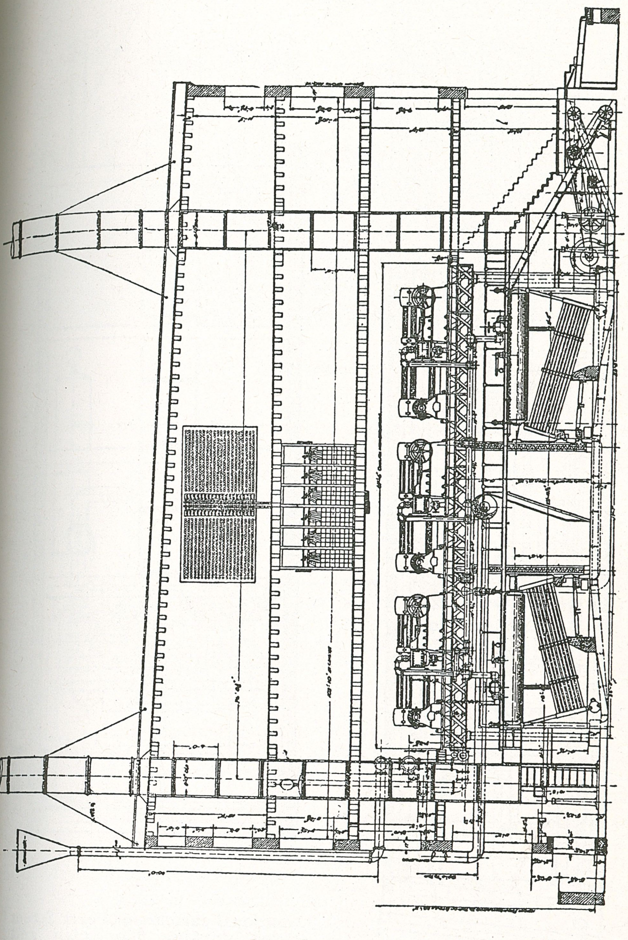
The property, 255-7 Pearl Street, New York City, occupied a lot 50x100 feet, and the building was four stories high, with a fire wall dividing it into equal parts, one of which was converted to the uses of the station, the remaining half occupied as a tube shop by the underground department, repair shops, storage, etc. The building was originally erected for commercial purposes, and as it was incapable of sustaining the weight of the engines and dynamos planned to be installed on the second floor, the old flooring was torn out, and a floor of heavy girders supported by stiff columns was substituted. This heavy construction, not unlike the supporting structure of the elevated railroad, was erected so as to be independent of the building walls, and occupied the full width of the building, 257 Pearl Street, and about three-quarters of its depth. This change in the internal arrangements, converting the building into an electric lighting station, did not in the least affect the external appearance.

A model, prepared especially for the collection of 'Edisonia,' exhibited under the auspices of the Association at St. Louis, showing the longitudinal section of the station and built on a scale of one inch equaling two feet, is shown in the photograph.(2) This model was constructed from an original blue-print of the building plans of the station, bearing date of 1882, and reproduced in the following page exhibited at St. Louis, together with detail sketches pre-

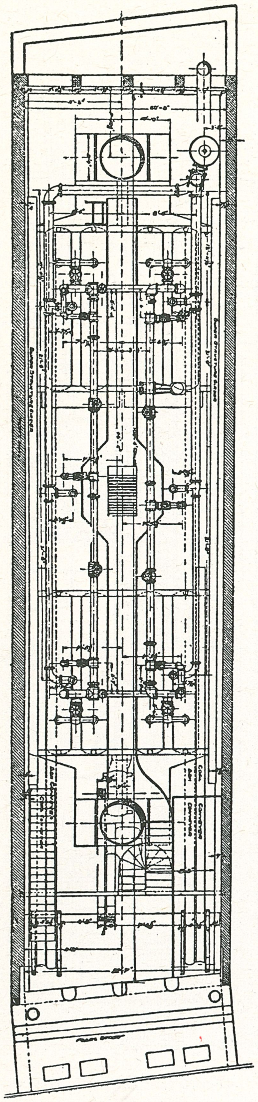


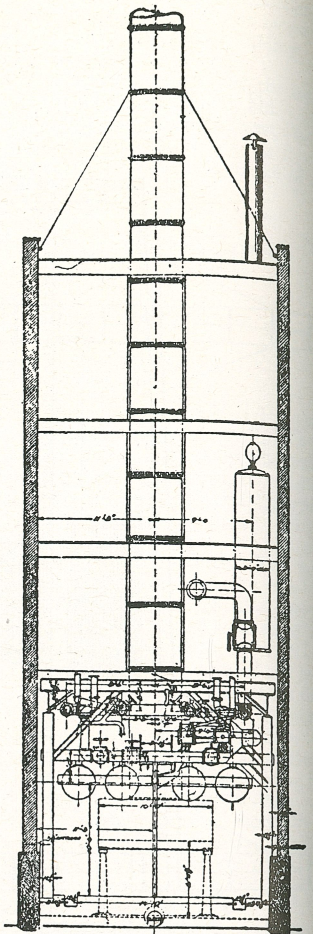
JOHN W. LIEB (1919).

(2) See cut on p. 1042.

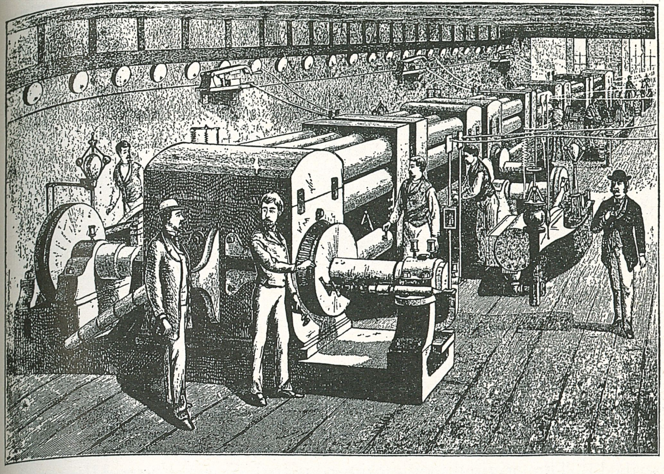


Original blueprint of the building plans of Pearl Street station, referred to at bottom of page 1046.





Additional sketches of Pearl Street station showing floor plan and (above) cross section.



The dynamo room.

pared. This model was in accordance with the recollection of a number of those who were at one time connected with its construction and operation.

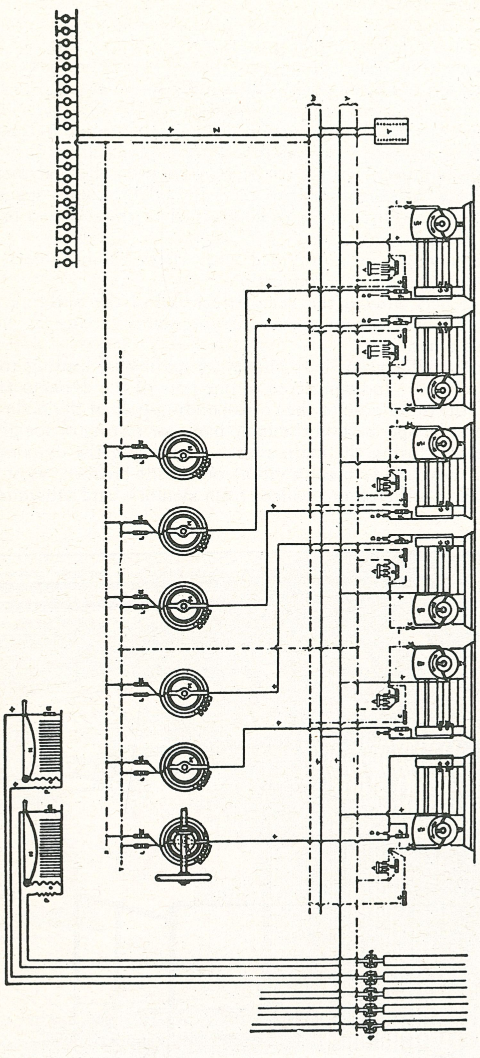
The vault under the sidewalk and the basement in the front of the building were fitted out with the machines for the receipt of coal and the removal of ashes. An engine of 20 horsepower drove, by means of countershafting, the screw conveyor for carrying the coal up over the boilers, from whence it was dropped by gravity to the stoke-hole on the basement level between the boilers, and the screw conveyor for taking the ashes from beneath the grates and discharging them into a barrel under the sidewalk. The engine also operated a fan blower, delivering forced draught to the furnace and supplying air for ventilating the stoke-hole. A system of blast pipes was also provided for blowing air to the armatures of the dynamos, as shown in detail in the general view taken for the *Scientific American* of August 26, 1882.

Four Babcock & Wilcox boilers, with a rating of 240 horsepower each, discharged their products of combustion into two steel stacks, one at each end of the building, and they supplied steam to the engines through an 8-inch header with 5-inch vertical branches. These boilers had cast iron headers, and as an evidence of the life of this class of apparatus it may be of interest to note that from the time this station was put into service, September 4, 1882, until March 31, 1894, they were in constant service at this station under very severe conditions; they were then removed and put into service at the 53d Street station, where they continued in regular service until May 22, 1902, nearly twenty years of practically continuous hard service.

A gallery extended over the boilers and gave access to the stoke-hole and the basement in the rear of the building, where a 'Z' dynamo (60-light) was installed, which furnished light during construction, and from which the current was taken for the first tests of the underground systems.

The boilers were provided with injectors, supplemented by a steam pump,

DIAGRAM OF DYNAMO CONNECTIONS



A. Main Circuit Breaker
B. Main Plug Multiple Arced with A.
C. Lamp Line or Starting Plug
D. Field Breakers
E. Dynamo Safety Catches
F. Field Charging Plug Multiple Arced with D.
G. Main Field Connections
H. Commutators
J. Feeders to Net Work
K. Lamp Line of Field Testing Plugs
L. Field Plug at Regulators for Main Circuits
M. Field Regulators
N. Feeder Regulators
O. Permanent Resistance in Feeder Regulators
P. Shunt to Equalize Resistance of Feeders
R. Feeder Regulator Plugs
S. Feeder Safety Catches
T. Switch Board to Throw In or Out Lamp Battery
U. Battery of 1,000 Lamps
V. Main Line
W. Lamp or Testing Main
X. Lamp or Testing Field Wire
Y. Field Main Line
Z. Cable of 20 No. 10 Wires connecting Lamp Battery to Switchboard T
N, S. Polarity of Field Magnets
Q. *Feeder Plug Multiple Arced with S.*

found to be accurate in every detail by comparison with old illustrations, was one of the earliest type of knife switches with contacts in series, and of previously unheard of capacity. It was operated by throwing the weight of the body on a long handle pivoted at one end, and released by heavy steel springs held by a trip pawl.

It will be noted that in front of the main contacts, and carried by the switch handle, is an auxiliary blade—the field circuit contact—making contact before the main line contacts engage, and breaking after the main circuit is broken. This field switch was supplemented by a plug switch attached to the wall and connected to a field circuit bus bar running the length of the station, with an auxiliary break through a lamp resistance to furnish a by-path for the field discharge.

The dynamo fields were controlled on an upper floor by moving simultaneously, through a horizontal shaft and bevel gearing, a number of horizontal contact arms over contacts connected with copper wire resistances wound on wooden frames. This will be clear from an inspection of one of the views, which adequately illustrates the enormous space occupied by this pioneer equipment.

It may now be interesting to state that when this pioneer station was started, and in fact for some little time afterward, there was not a single electrical instrument in the whole station—not a single voltmeter or ammeter! There was also a total absence of a central switchboard, as each dynamo had its control switches located at the dynamo; the feeder connections were concentrated at the front of the building, and the voltage control was on the floor above. The pressure was regulated from the indications of an automatic indicator, consisting of an electromagnet connected across the main circuit, and whose pull was opposed by a heavy spring. The armature of the magnet carried a contact which engaged two relay contacts on the high side connecting with a relay circuit to a red lamp, and on the low side with a circuit to a blue lamp. At normal pressure neither lamp was lighted; but if the electro-motive force rose above a predetermined amount one to two volts, the red lamp was lighted, and the attendant at the hand-wheel of the field regulator inserted resistance in the field circuit, and if the blue lamp was lighted, resistance was cut out until the pressure was raised to normal. The station was equipped with several of these indicators, and the writer remembers with what care, and incidentally physical discomfort, he carried the indicators back and forth every few days from the Edison Machine Works at Goerck Street (where they were adjusted by comparison with a Thomson reflecting galvanometer and battery of standard Daniell's cells) to the station, the belt-line horse-cars affording a welcome assistance in the transit. Later on this primitive indicator was supplanted by the 'Bradley bridge'—a crude form of the 'Howell' pressure indicators in use for many years in the Edison stations.

In the adjoining building sleeping accommodations were provided for the station assistants, and here Mr. Edison passed several months day and night making experiments and tests in connection with the starting up of the station.

On one of the upper floors of the station building was located the meter room, where the plates of the 'Edison' chemical meter were prepared and weighed.

As stated previously, the station was started September 4, 1882. On October 1, 1882, there was connected to the station, in customers' installations, 1,284 lamps; on January 1, 1883, this had been increased to 231 customers, with 3,477 lamps. The first motor was connected to the system in 1884, and the first multiple arc lamp in 1889. The original underground system—a two-wire

system—had a total length of Edison feeder and main tubes of about 18 miles, and covered the district extending from Wall Street to Spruce and Ferry Streets, and from Nassau Street to the East River, a territory covering about one square mile.

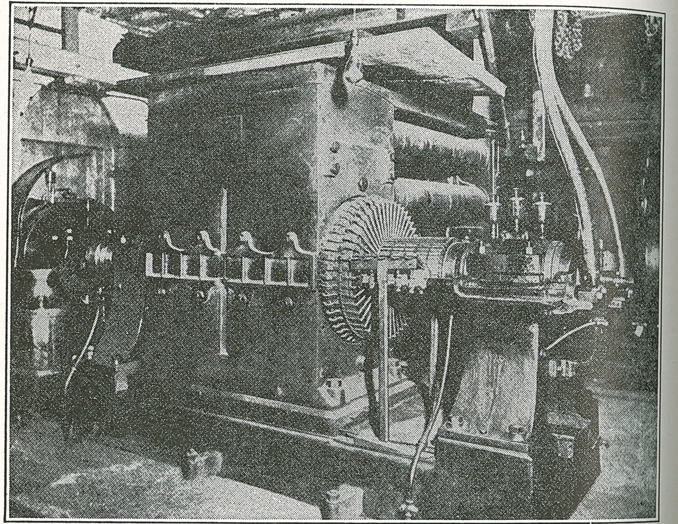
A description written some months before the station was started, concludes as follows:

'This electric lighting station is very complete in all of its appointments. Every imaginable emergency has been provided for: coal bunkers in the top of the building to hold a reserve of coal, water tanks to supply water in case of any deficiency or cessation of supply, thorough protection against fire, and thorough workmanship everywhere.'

Yet it fell a victim to the fire fiend, for on January 2, 1890, the station was totally destroyed, causing the only serious interruption in the supply of current to the New York Edison system that had occurred previous to that time or since then, and only one 'Jumbo' survived the wreck, and that is now a prominent feature of the collection of Edisonia at St. Louis. A view of this 'Jumbo' in its original location in 257 Pearl Street, closes the series of illustrations.

In looking over the details of this pioneer equipment, one sees here represented many important elements which were characteristic features of the electric light stations built for many years afterward, contributing notably to their technical and commercial success; in fact, in its equipment of direct-connected units it was unique, as this type of apparatus fell into disuse and neglect for over ten years, only to become the standard equipment for all important power stations.

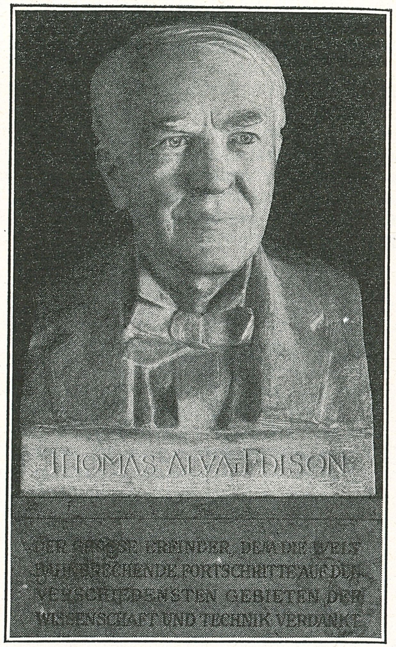
The building was sold in 1895, and there is now nothing left to mark the



Only existing dynamo of the six with which the Pearl Street station was originally equipped. Now in the Edison historical collection in Dearborn.

storic spot, such a conspicuous landmark in the history of the art of electric hting.

In closing this review of the historic Pearl Street station, it should be ointed out that this was the station which did the remarkable work of demonrating not only the practicability, but also the commercial success of the dison multiple arc system—that epoch-making series of Mr. Edison's inventons from the steam dynamo to the lamp, including the dynamos, regulators, eder and main system, underground distributing system, safety fuses, cututs, switches, sockets, meters, and last, but not least, the crowning achievement—the incandescent lamp.



Courtesy Deutsches Museum, Munich, Germany.

THOMAS ALVA EDISON

Translation of inscription reads: "The great inventor to whom the world is indebted for the extraordinary progress that he made in various fields of science and technics."

CII. The Pearl Street Central Station

(PART THREE)

WE MUST not forget that the company that erected he Pearl Street station was the Edison Illuminating Company of New York, organized on December 17, 1880, and that this company, like others that followed, had to obtain its license from the parent company, The Edison Electric Light Company, which held all of Edison's patents. The incorporators were James H. Banker;

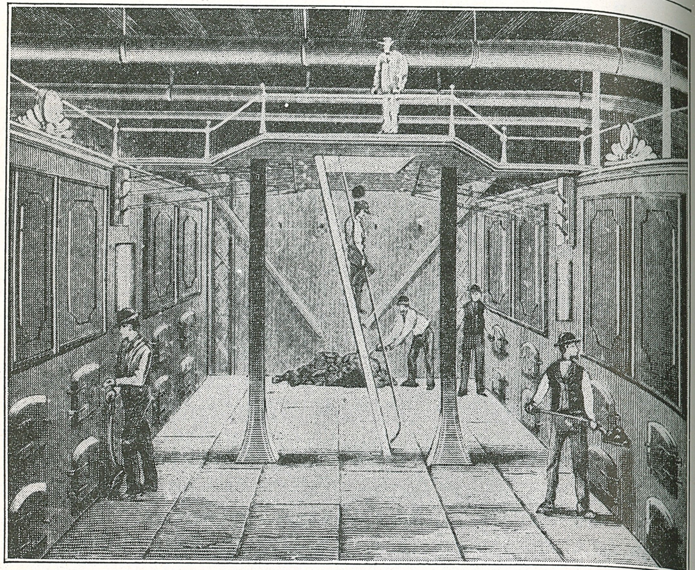
Tracy R. Edson; Robert L. Cutting; Egisto P. Fabbri, who was a partner of J. Pierpont Morgan; Jose F. de Navarro, also connected with Drexel, Morgan & Company; Grosvenor P. Lowrey; Nathan G. Miller; and Thomas A. Edison.

The following directors were present at the meeting held on December 20, 1880: Tracy R. Edson, Henry Villard, Major Sherburne B. Eaton, E. P. Fabbri, Dr. James O. Green, R. M. Galloway, Nathan G. Miller, and Robert L. Cutting. Dr. Norvin Green was elected president; Calvin Goddard, secretary; and E. P. Fabbri, treasurer. Major Sherburne B. Eaton was elected vice-president on March 23, 1881, and on December 16, 1881, Edison was appointed engineer. Ha! Ha! Who would have engineered all if not Edison, for on him all depended still.

In one of the early reports to the Board of Trustees, Major S. B. Eaton, vice-president, said: 'Your enterprise was one of peculiar boldness. Starting almost from the moment that Mr. Edison had demonstrated the scientific success of his great invention, you undertook to apply practically, and to its fullest extent, a system which had scarcely been tried at all, except in the laboratory, and which, as far as underground and central station work was concerned, existed only theoretically. When the construction of the present central station was commenced, there were in use, perhaps, a half dozen small, imperfect isolated plants; and with only those to guide you, you undertook and have carried to scientific and financial success the great problem of underground central station lighting by electricity in competition with gas.'

The first mechanical superintendent of the Pearl Street station was Joseph Casho. Although a fine mechanical engineer, he was used to the slow-speed engines making seventy-five revolutions a minute, and, therefore, did not feel at home with the high-speed engines making 350 revolutions. He left the service in the Spring of 1883.

It was also said that the bookkeeping at the station at the time was not of a high order; so Edison resolved to place a man with commercial abilities at the head of the operations and engaged Charles E. Chinnock. It was said that Chinnock had been an able and conscientious manager of the Metropolitan Telephone Company, and Edison guaranteed him a bonus of $10,000 if he succeeded in putting the station on a paying basis. He did it, and we all know that Chinnock became a veteran Edison man for years. I am getting ahead of my tale;



Boiler room of the Pearl Street Central Station.

step by step the station was getting in shape and the time soon came for testing. Edison never for a moment imagined that everything would run smoothly at first; on the other hand, he never thought that his station would not be a success.

Many things happened, but the master soon found ways and means of setting them right. Sometimes comical effects came up that supplied mirth for the newspapers. For instance, on June 29, 1882, the first fires were started under the boilers in the first electric power station at 257 Pearl Street, New York City. Tests were undertaken to try out the individual parts under regular working conditions. The steampipes were given pressure tests, and the auxiliary steam engine which operated the coal conveyors and the blowers that were to prevent the accumulation of heat in the armatures, was subjected to time trials. On July 5, the first steam dynamo was started, and the others followed from that time on, during which tests were made with the 1,000-lamp bank installed on the upper floor of the station to give to each steam dynamo

a working load before it was switched on to the feeders. The field regulating apparatus was tried and necessary adjustments made.

Those days and nights were filled with critical and exciting moments. All tests were most thorough and complete. Even outside bridgebuilding experts were called in to try the iron structure upon which the six steam dynamos rested. Then Edison began to test his station electrically and many trials and experiments were made, furnishing valuable data of a commercial nature for the future operation of central stations. The tension indicator designed by Edison for controlling the electrical pressure at the feeder ends of his underground network was put into operation and found satisfactory. Its proper working and standardizing was one of the functions especially confided to Lieb. The underground network was tested by Herman Claudius, an Austrian veteran of the old school, and its insulation was found perfect. In the tests of a radically new system, of course, certain unexpected things will happen, and minor defects will appear from time to time; that was the reason Edison conducted such careful trials before permanent operation of the plant began.

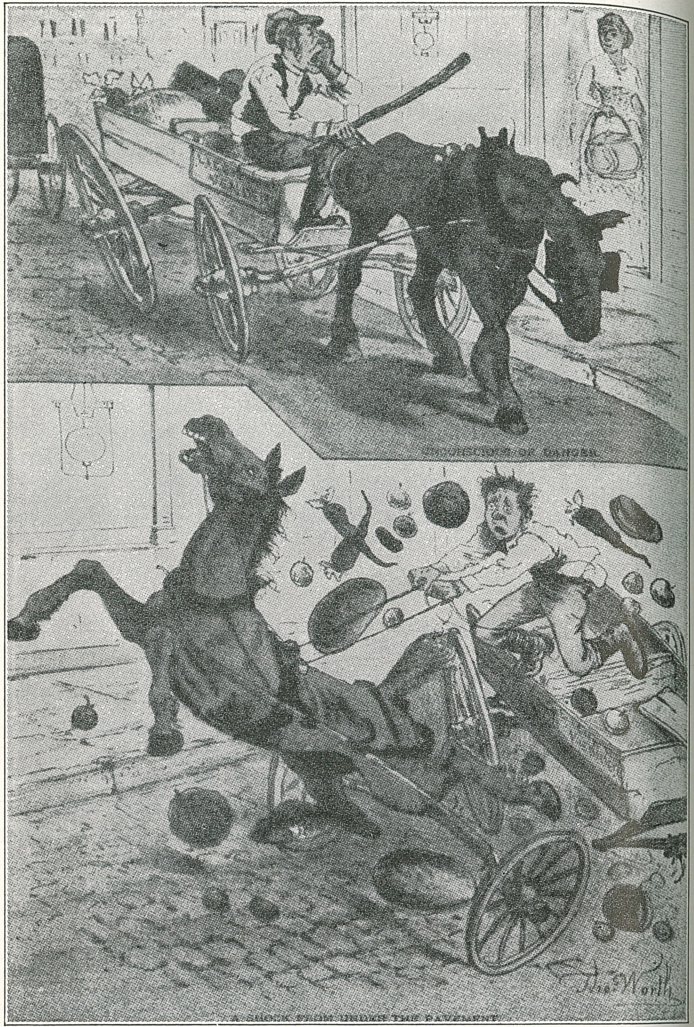
On August 24, 1882,(1) the steam dynamo was running without a hitch, the underground system received its full pressure, and the staff at the station was well-satisfied with the results. Shortly, however, a police officer appeared at the station. He announced that some of the 'juice' must be leaking out at the corner of Nassau and Ann streets, because all horses passing a certain spot exhibited certain equestrian antics such as had never before been witnessed.

It was a great day for journalism and the *Herald*, *Times*, *Tribune*, *Sun*, and other papers all printed amusing accounts of the affair. Some of the incidents they recorded follow:

'A peddler of tinware, with a ten dollar "nag," drove through the crowd. At the moment he entered the charmed spot, his quadruped gave a snort, and, with ears erect and tail pointing to the North Star, dashed down the street at a 2:40 gait. Roars of laughter followed the terror-stricken peddler as he grasped the reins with one hand and with the other endeavored to hold down his dancing stock in trade.'

'A farmer with a sleepy sorrel plug also drove by. The old mare began a double-shuffle on the cobblestones. The

(1) From Francis Jehl, *Edison Monthly*, July 1928.



Startling effects of the leak in the Edison system as pictured by Thomas Worth in *Judge*.

farmer rubbed his eyes and gazed with astonishment at the remarkable evolutions of his hitherto peaceful beast.'

'Next came a big truck loaded with paper. No sooner had the horses stepped upon the magic spot than they dropped kicking upon their knees.'

'Next came a one-horse van of an express company. Again the crowd parted, making a lane in such a fashion that the horse had to pass over the mysterious spot, but they looked innocently at the driver in response to his inquring gaze. When he turned around after the horse had bolted and he had him under control again, the puzzle was so intricate that he forgot to swear till he got to Beekman Street.'

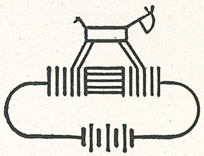
At the power station a reporter began to shoot inquiries at Clarke, who took off his glasses and slowly started to clean them with his handkerchief in order to consider his replies. He then cautiously began: 'The explanation of any trouble of that kind is very difficult. In fact, we haven't given it consideration yet, and we have no evidence that the shocks, if there were any, came from our station.'

'You have wires laid at that point.'

'Yes sir.'

'The question is then, would it not be possible for a horse to be affected by the electricity from your wires?'

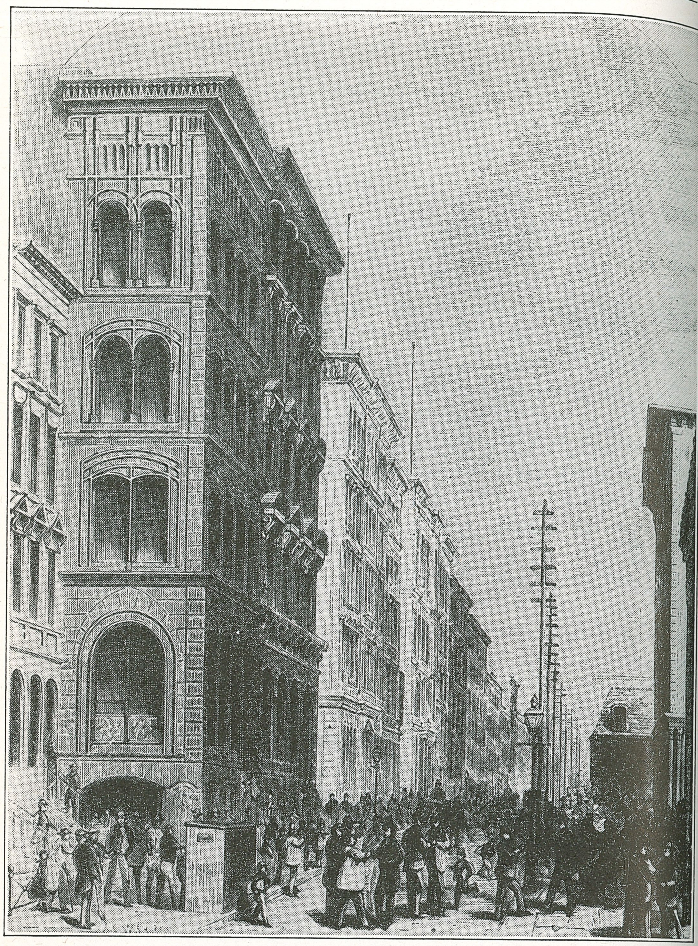
'We can say, generally speaking, that if you should connect two poles of any electric battery or dynamo to two pieces of damp ground, while a current was prevented from passing from one to the other by an intervening spot of dry ground, of course, any animal or other conductor in passing over the strip of dry ground, if it were narrow enough, could make contact between the two poles, and could receive a shock.'



Clarke s Sketch.

Then Clarke drew a sketch that explained the Nassau Street mystery without confirming it. Later on in the day, Edison told Clarke that the leak occurred because some men who had dug there had spiked one of the electric tubes.

Well-known electricians of that period began to discuss this little and unimportant occurrence seriously, and one of the sages said: 'The electrical world in general, and Mr. Fdison in particular, have been confronted with a new problem which no amount of forethought unaccompanied by



Nassau Street, north from Wall Street. Several blocks up Nassau Street the leak occurred.

practical experiments could have guarded against. It is evident to me that Mr. Edison will have to devise another system of underground conductors that will meet the requirements of the conditions which we now see are imposed upon

him before he can ever hope to reach a practical and commercial success in his enterprise.'

Nevertheless, disregarding the 'worry hunters,' the Pearl Street Central Station was started on September 4, 1882, and the Edison system and underground conductors gave more than satisfactory service for decades.

Another somewhat similar incident of a different character happened at the corner of Nassau and Ann streets. As is known, Edison placed cast-iron junction boxes at the intersection of the streets, in connection with his underground conductors. Late one night when he was still at the station, a policeman came running in and in an excited voice said that the iron box at the above-mentioned corner had exploded. Edison and one of the 'boys' went there to see what had happened. He found that the cover on the manhole, which weighed about a couple of hundred pounds, had vanished, but everything inside the manhole was in good order. Edison concluded that gas from a gas main might have got into the manhole, or it might have been the acid used in pickling the casting that gave off hydrogen that mixed with the air leaking in to make the explosive mixture.

The incident worried him; there were many such manhole boxes in the system, and if one should explode in a crowded street and lift a few persons into the air the company might be compelled to pay damages. Edison got his 'thinker' in action and soon solved the problem. He placed a little bottle of chloroform with a small hole in the cork into each box. The chloroform evaporated and, being heavy, settled in the box, displacing the air that may have got in. Edison said afterward that he had never heard of an explosion in a box that had a bottle of chloroform in it.

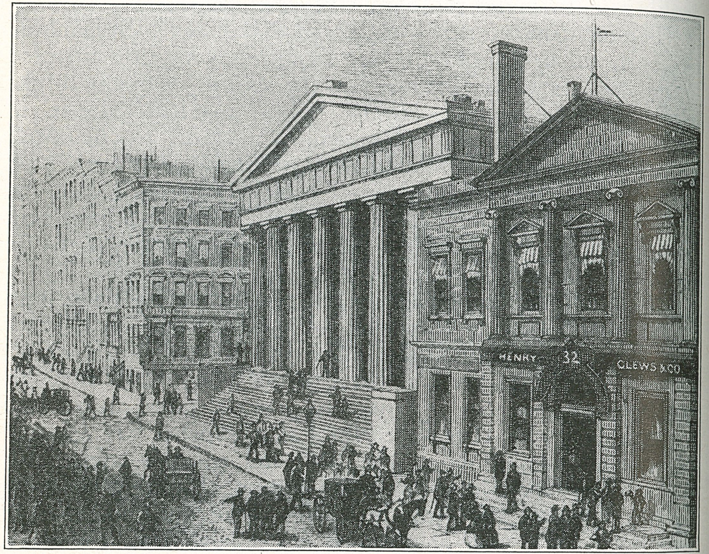
Many things came to pass, and it was only Edison who could and had to ferret them out. It seemed that destiny hinted to him that he now had his system working on which he had labored some years, but it would have to pass through the infant period during which so many changes take place.

There was the time when lines and branches had a safety catch on only one leg of the line, and another safety plug happened to be placed at another part of the installation on the opposite pole; that is, a safety plug was on a positive line somewhere and another on a negative line. When a ground happened to arise on a plug-and-negative line, a 'fine' short would spring up. It was soon found that to protect both

positive and negative poles against shorts, each pole must have a safety catch, or fuse. Hammer told me that when he supervised the London Holborn Viaduct plant he found that out, and thus used two fuse blocks for all line derivations as well as at the main line.

Old-timers will remember that at first only single fuse blocks were made and used. Many antics and curious happenings often took place on account of only protecting lines with one fuse, and the experiences that C. S. Bradley and his assistant, S. S. Wheeler, acquired in those days were real eye openers.

Edison was everywhere, for his occupations were multifarious; and all looked to him for advice when anything went wrong. The memorable day when the Pearl Street Central Station was started in regular operation happened to be September 4, 1882. On that day John W. Lieb, the electrician of the station, was deputized by Edison to close the main switch, thereby permitting the current to flow into the underground conductors, and thus to start the regular operation



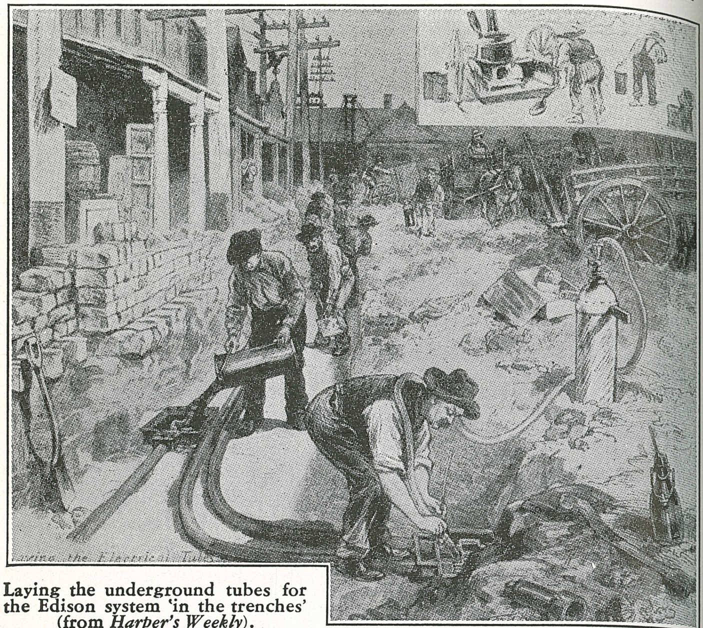
Treasury Building and Wall Street, looking west. Opposite was the Drexel Building (see Vol. 1, p. 9) where Edison first turned the switch to light Morgan's office.

of this novel enterprise. This act required that Lieb stand on his tiptoes, and finding that the catch of the switch did not work properly, he had to hang on to its handle until William D. MacQuesten, Lieb's assistant at the time, brought a bench and pushed the catch into the pawl that locked and held it.

At that time Edison, Johnson, Clarke, and other officials of the Edison company were at the offices of Drexel, Morgan & Company, corner of Wall and Broad streets. There C. S. Bradley inserted the service fuses of the building, and then Edison personally turned on the lights in the presence of Mr. John Pierpont Morgan. Edison was pleased, and Jumbo No. 9 was working fine. To a reporter who accosted him he said: 'I have accomplished all that I promised, and the only engine running now can supply over 1,000 lamps.' People passing to and fro in Fulton Street that night stopped and gazed into the stores and wondered at the soft, mellow lighting. All kinds of inducements were made to the first customers. They obtained free wiring, and no bills were sent until about six months later. As I have previously said, everything went well and continued so, not considering certain incidents that came up and that Edison always found ways and means to remedy.

I have not told yet that at the time the laying of the Edison underground tubes began, in the Summer of 1881, Edison and Kruesi were observed some days and nights in the trenches supervising the operation of the work. It was generally at night, as the work could proceed better then than during the daytime. A sixty-lamp 'Z' dynamo that was driven at the station supplied not only the light but also the current for testing the tubes before and after they were laid in the ground. Even when Bradley was intrusted to conduct the work with a gang of men, Edison and Kruesi would often appear during the night and determine how things were going. At the station were cots on which they could rest or take a nap.

I remember that I often went down to the Pearl Street Central Station during the night when they first began to lay the tubes and watched them; now and then I was commandeered by Edison for some work. One day during the late part of the Summer of 1881, at about 11:00 p. m., I went to the station and found Edison and Kruesi each lying on a cot discussing matters regarding the tubes and the laying of



Laying the underground tubes for the Edison system 'in the trenches' (from *Harper's Weekly*).

them in the trenches. Now and then Edison would jump up, pull a piece of paper out of his side pocket, and make a sketch, explaining it to Kruesi.

In order to insure success, Edison went far beyond the obligations he had to his company. It is said that when everything was ironed out and the station was running in good order, it developed that the company could not yet pay its operating expenses. Its funds were low, and some directors began to murmur about furnishing more cash. Edison had such faith in his station that he personally, out of his pocket, raised the cash and tided the affairs of the company until it was on a paying basis.

Yes, not only to the Edison of Menlo Park but also to the Edison of the Pearl Street Central Station is the world indebted for the advance we have today. In commenting on this, I must also add the Edison of the Thomas A. Edison Construction Company; all put together they made 'The Great American' who is so honored today.

Through my old friend, William I. Donshea,(2) I received, many years ago, some interesting facts and data concerning the Pearl Street Central Station. He, like E. A. Harley, came to that first station when it was in regular operation. They with a few others could tell the tale of the fire and other facts better than the scribes of the newspapers who reported it at the time. The information that I received from Donshea was all recorded in the *Technical Bulletin*, to which the executives of the distributing stations of the New York Edison contributed their reminiscences from time to time. Their information came from practical experience, and they rose to become heads of departments and to hold responsible positions later on.

The following is E. A. Harley's contribution on the 'Pearl Street Station and Restoration After Its Destruction by Fire':

'The Pearl Street Station was the culmination of the work of Mr. Thomas A. Edison in the development of a central station with the attendant distributing system for the furnishing of electric current for lighting with the use of incandescent lamps. The station was located at Number 255-257 Pearl Street and was on the west side of that street about one hundred and twenty-five feet south of Fulton Street. The buildings had been four-story loft structures of similar design and had been converted during the early part of the year 1882 to the purposes of the station.

'Viewing the station in 1884, the north building (No. 257) had, in the cellar and through the first floor, the four Babcock and Wilcox boilers with the pumps, injectors, forced draft fans and other steam paraphernalia; the second floor was the generating room in which were six Jumbo units, the dynamos connected to bus bars that ran around the walls of the room and terminated on the south wall in the front of the room, at which point the tube feeders were connected through a safety catch to the bus.

'The floor of the generating room was clear of the walls of the building, all the generator units resting on a structure that was compared at that time to the elevated railroad construction, the base of the columns supporting the floor resting on the earth. Much comment was made by visiting engineers on having the heavy weight of revolving apparatus installed

(2) William Isaac Donshea, born August 2, 1858; died December 21, 1931.

in this manner, and they were generally surprised to find no vibration in the structure.

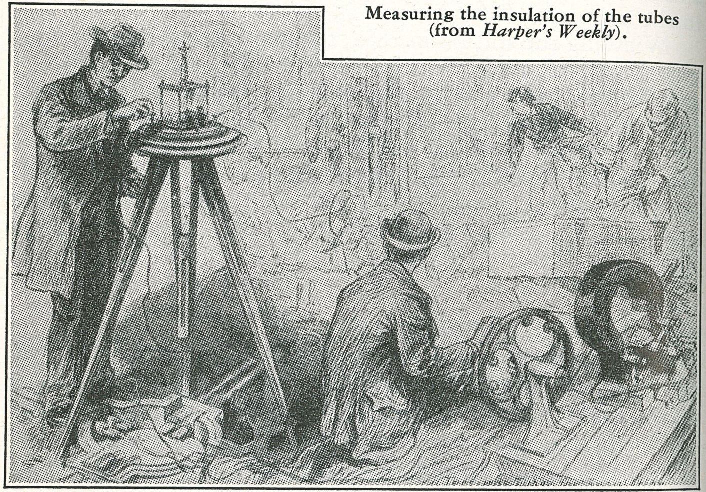
'The third floor was mainly used for the field rheostat room, and on this floor was the district office in which there was three persons engaged including the superintendent.

'On the fourth floor was the meter room and the reserve supply of incandescent lamps. Also, on this floor was a large butcher's ice box which, it was stated at the time, had been used for the testing and setting of the thermostats in the chemical meters. These meters had an incandescent lamp installed in them, and when the temperature in the meter reached a predetermined low point, the lamp would light and the heat from the lamp would prevent the solution in the bottles from freezing.

'Also on the wall on this floor was a bank of a thousand lamps which was used for testing the dynamos, and also used when starting a machine, lamps being brought up to candle power before closing the machine on the bus.

'In the south building (No. 255) the rear half of the cellar was occupied as a coal bunker, the coal being received in the vault under the side walk and wheeled in wheelbarrows back to the bunkers and then wheeled from the bunkers to the boiler room as needed.

'In the front half of the cellar were two Jumbo units which



Measuring the insulation of the tubes (from *Harper's Weekly*).

were installed and placed in service in 1884, the first additional installation made in a central station that was not included in the original design of the station and made for the purpose of taking care of increased business. These units were at the bottom of a well that went through the first and second floors, and could be observed in operation from the main generating floor.

'The first floor, of which there was only the rear half, was used for underground material. A small machine shop was on the second floor where minor repairs to parts of the apparatus were made.

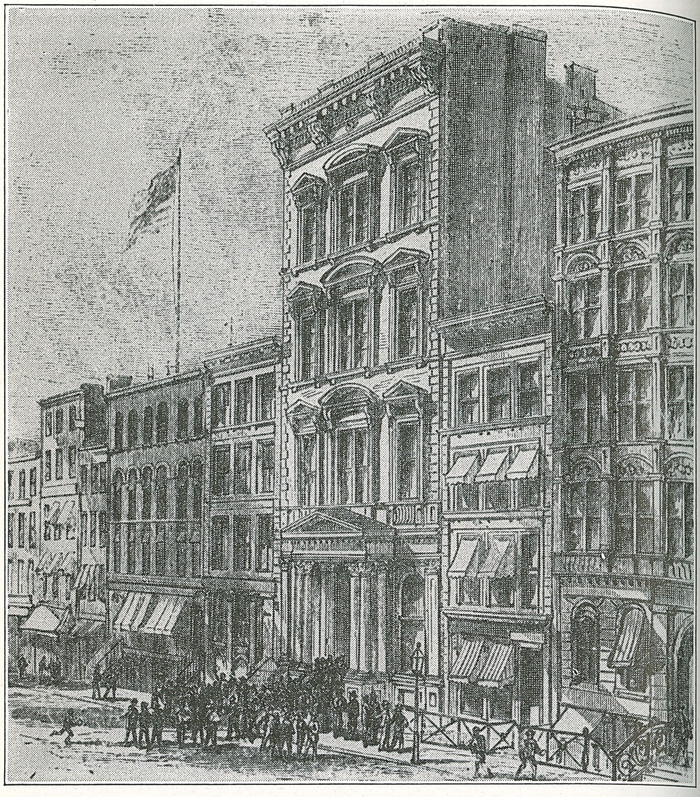
'The front of the third floor was occupied by the test room or, as it was known, the station electrician's room. This room in its complete equipment had a photometer, several Wheatstone bridges and some Thompson galvanometers. The writer does not recall seeing either a stationary or a portable voltmeter in the room at this time.

'The rear of the third floor was fitted up as sleeping quarters, and it was here that Mr. Edison and his assistants frequently got their rest during the construction period. At this time it was being used by the night underground foreman and one of his mechanics who would be called upon to augment the force in case of any daytime emergency.

'The fourth floor was used as storage of miscellaneous material.

'The station was first placed in service on September 4, 1882, and was operated continuously until Thursday, January 2, 1890, when, at 6:10 o'clock that morning the entire contents, with the exception of the boilers and the smoke stacks, were destroyed by fire. The boilers were saved by the heavy over-head structure of the second floor preventing any heavy weights crashing through on to them, and also through the heroism of the engineer on duty, William Carlin, who stayed until he had put the boilers in a safe condition and fought his way, through heat and smoke, to the front vault where he emerged to the street through one of the coal hold openings in the sidewalk.

'The station at the time of the fire, together with an annex station at 60 Liberty Street, which had a capacity of four number twenty (60 KW) bipolar Edison dynamos, was serving the area between Exchange Place, Spruce Street, Broadway and East River with stub mains extending from these boundary streets serving a few customers outside this area.



New York Stock Exchange, diagonally opposite Drexel, Morgan & Company.

'During the time the Pearl Street Station was out of service after the fire, the Liberty Street annex which had been used only as a daytime station was placed in twenty-four-hour operation and two No. 20 dynamos, one to each engine, was added to the plant. The method of operation of this plant at this time was to concentrate its service into the Wall Street area during the day, cutting off the underground system from the north end of the district during this period. After the business day had concluded in the Wall Street District, the underground system to the north end was re-connected, giving service to these customers in this area, particularly

Newspaper Row, from early evening until business started in the south end of the district the following morning.

'The fire was primarily caused by a short circuit in an underground feeder at some distance from the station which caused the unit in the station that was operating at the time to burn out from overload. The burning insulation and molten metal were thrown from the machine into the area where the lubricating oil was kept, and in this way the fire was communicated to the building.

'The Fire Department was through its work and had departed at ten thirty a. m. when all the employees, not otherwise engaged, were started on removing the light debris that blocked the entrance to both buildings. In the meantime, local real estate agents had been interviewed in the endeavor to locate a site in which there was steam power and empty space. This inquiry did not proceed far as, during the late forenoon there was a sidewalk conference composed of a number of persons interested including Mr. Edison and Mr. John Kruesi, the head of the Schenectady works of the Edison General Electric Company. After the situation had been canvassed, Mr. Edison and Mr. Kruesi withdrew to one side and, on top of a salvaged, half-burned desk with a partly burned pad of paper, they drew a few rough sketches and the general plan of reinstallation of apparatus was evolved.

'The whole work of rehabilitation was turned over to the Edison General Electric Company and that evening Mr. J. "Pop" Turner, a head of a department at Schenectady, and his gang of huskies were on the job and began to organize and proceed with the work.

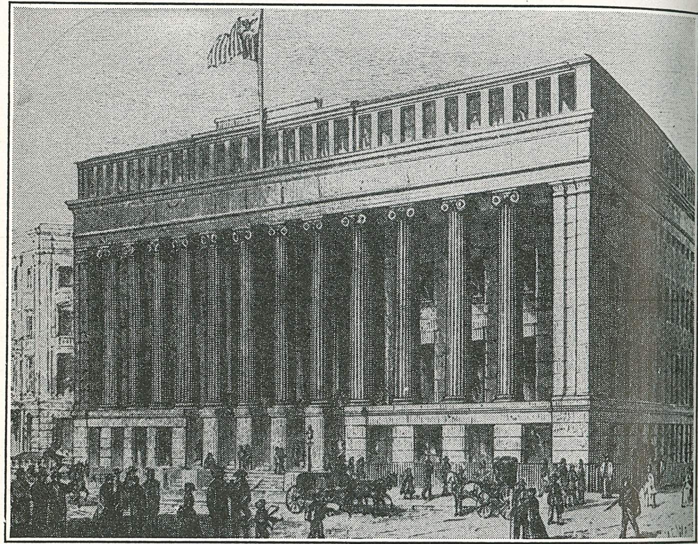
'All work was then concentrated on the south (No. 255) building, as the plan was to install the new generating apparatus and switchboard in the cellar of this building. Starting at the roof, removing the partly burned timbers of the roof and the different floors, the interior of the building showed nothing but bare walls above the first floor except for the timber bracing from wall to wall. While the burned material was being removed from the lower level of the building, the roof and floor timbers were being placed, and before the lower part was cleared, the roof was completed at the old fourth floor level because of the weakness of the upper walls due to the heat of the fire, and good progress had been made on the other two floors. On the lower level, the coal bunker was quickly uncovered and the coal transferred to the boiler

room. Almost all the debris had to be removed before the two Jumbo units were uncovered, and the removal of these units was comparatively slow work owing to the large and heavy parts that had to be handled.

'The fire happened on Thursday morning and on the following Wednesday night the entire building was cleared to the smooth surface of the earth in the cellar.

'In the meantime, the office of the Edison General Electric Company had been busy gathering together the engines, dynamos, switches and meters for the installation. The engines were found scattered in the eastern section of the country and were ordered delivered to New York by express, and the Edison General Electric Company diverted shipments of dynamos that had already started from the works; and dynamos that were about completed in the works on other orders were brought to New York by express.

'With the completion of the clearing of the building, heavy timbers were laid on the ground to furnish the foundation for the engines, the timbers being embedded in concrete.



The old Custom House on Wall Street.

In the layout of the floor, an alleyway was allowed for along the north wall from the front to the door of the boiler room to furnish a way to wheel the coal from the sidewalk vaults to the boiler room. This alleyway was roofed over to provide a walkway from the street entrance door to the stairs that led down to the center of the generating room.

'The work of opening the joints of the tube feeders in the sidewalk vault had been going on, and cable was connected to divert the feeders to the new switchboard. The cables were brought out of the vault in No. 257 into No. 255, and the cable supports for the run to the switchboard were provided by the wooden uprights making the support of the walkway over the alley.

'The switchboard was placed on the room side and at the west end of the alleyway, and the only description that can be given that could be generally understood would be to say that it was a board fence covered with sheet asbestos. All switches placed on it were of the complete unit type with slate base and surface lug connections.

'As soon as the floor was ready, the engines and dynamos were delivered and set in position and as soon as they were located on the floor the piping for the engines and the cables and control wiring for the dynamos was run and the belts from the engines to the dynamos placed.

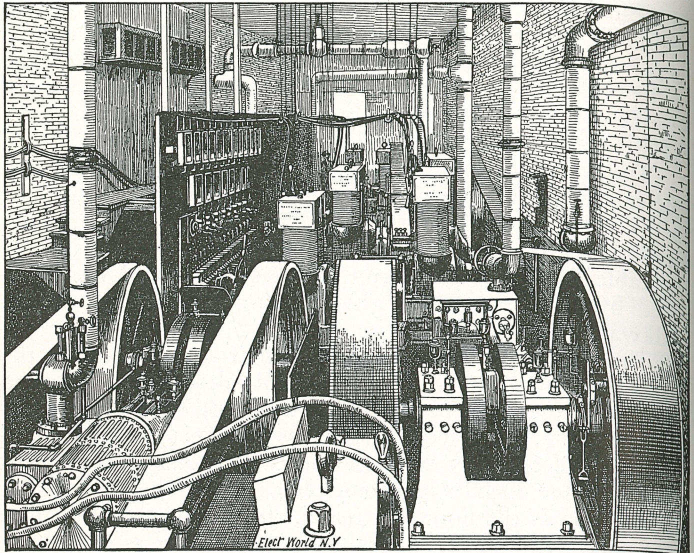
'With great activity the work of installing the apparatus proceeded from Wednesday night and resulted in the starting and placing on the bus the first engine unit with two No. 32 (100 KW) bipolar Edison dynamos on Sunday night, January 12 at about eight o'clock.

'This restored service from Pearl Street Station after a period of shutdown of about 254 hours.

'Twenty-four hours later, Monday, January 13, the second unit of two No. 20 (60 KW) bipolar Edison dynamos went into service.

'Again, twenty-four hours later, the third unit of two No. 32 (100 KW) dynamos was placed in service. There was a delay in placing the fourth unit into service owing to the necessity of replacing some missing engine parts, but the unit, consisting of two No. 20 (60 KW) bipolar Edison dynamos went into service on Monday, January 20. This completed the replacement installation and gave the station a capacity of 640 KW.

'At a later period a No. 20 bipolar dynamo was added to



Reconstruction of the Pearl Street station after the fire.

one of the larger engines, and a No. 16 to the other large engine by the use of tandem belts on the same flywheel.

'With nothing but the finishing work to complete in the No. 255 building, attention was given to clearing the north, No. 257 building. The damage was more complete, if that was possible, in the latter building above the second or generating room floor than it had been in the adjoining building. When the loose debris had been removed, and the Jumbo units uncovered, difficulty was had in removing these from the second floor to the street because of the very limited room for handling. On a survey it was decided that No. 9 unit, the one nearest the front of the building, could be repaired and placed in service again, but the other five units had been subjected to such intense heat that they were worthless. The five units were removed from the building and later the remaining unit was repaired and placed in service and used at the peak loads until early in 1893 when it was removed from the building and placed on exhibition at the World's Fair in Chicago.

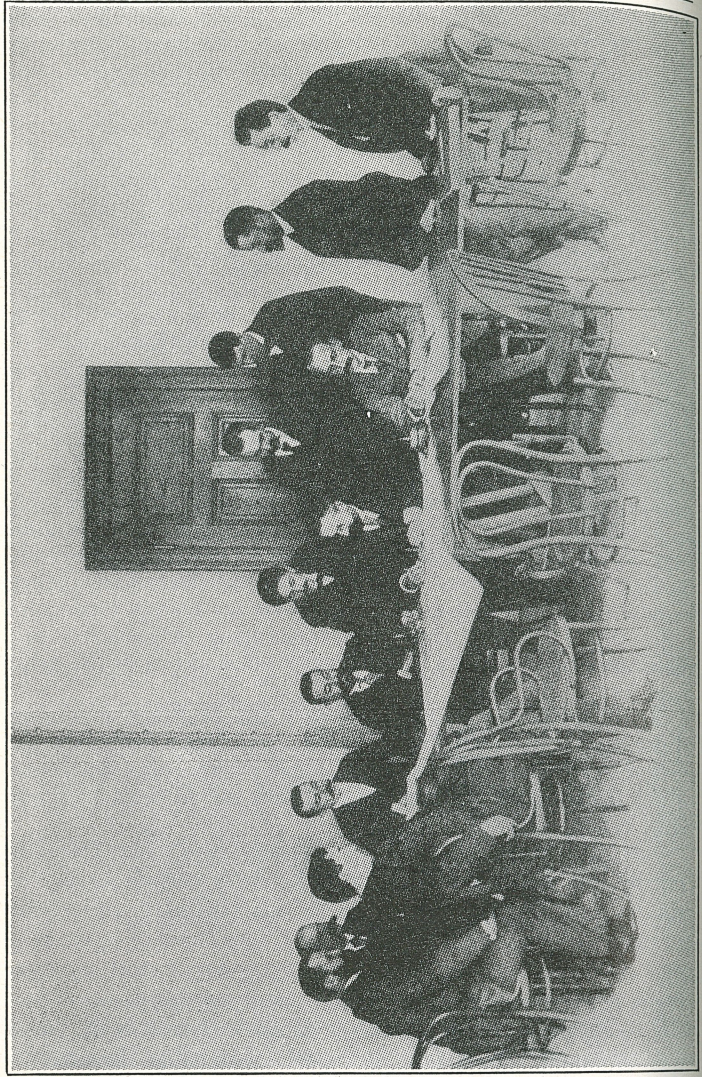
'Before any of the five destroyed Jumbo units had been removed, a roof had been placed on the building at the same floor level as in the other building, for the same reason, and the third floor was not replaced as it was decided to use the space as a coal bunker. A bulkhead was erected at the east end of the second floor directly behind the No. 6 Jumbo unit, and another bulkhead placed at the west end of floor made up the area of the new coal bunker. A Link Belt elevator and conveyor was installed and, with holes and chutes through the second floor, provided for handling the coal by mechanical means and gave a gravity feed for sending the coal into the boiler room.

'This station was continued in regular service until 1895, when, with the increase in capacity at Duane Street, the capacity of this station was found unnecessary and it was dismantled, and at a later date the property was sold.'

From this description old-timers will again recognize and recall what an important position John Kruesi held in those trying times. Not only was he the very heart and soul, after 1889, of the Schenectady works, which were at that time under the control of Villard, but when the fire destroyed the Pearl Street station—yes, in that critical state of emergency —the energy and vision of Kruesi also set things into rapid action that brought about the restoration of Edison's pet, the Pearl Street station, to the entire satisfaction of the great inventor.

Then again we must not forget the brilliant maneuver of the company's men that brought the Liberty Street station into action, so as to provide the most important customers of the Pearl Street station with current while the latter was under reconstruction.

The following contains interesting data that Donshea contributed to the bulletin. All the facts pertaining to the first current supply station invite our curiosity and excite our emotions, for they depict the long, hard trail of pioneering work that brought us where we are today. And no facts are so trustworthy as those that came from the pioneer himself, or those written by one who understands what he is writing about. It is only personal knowledge that counts when a book is written, worthy of its ink and paper, for then it benefits the reader. We have too many synthetic compilers nowadays.



Staff Council of the Edison Illuminating Company of New York, 1896. Left to right—H. A. Campbell; Joseph Williams; Arthur Williams; Hi. M. Edwards; John W. Lieb; John Van Vleck, vice-president; R. R. Bowker; H. J. Smith; Henry Stevenson; Frank Enos; Charles S. Sheppard and W. I. Donshea. Most of the group were veteran pioneers of the Pearl Street Central Station.

Donshea recalls:

'When Mr. H. J. Smith, then electrician of the company, gave me a job as helper in the Pearl Street Station in March, 1887; the company had two stations, one in 255 and 257 Pearl Street and the other in the basement of the Jere Johnson Building, 60 Liberty Street.

'In Pearl Street, the plant was located in the northerly building, No. 257, and consisted of four Babcock-Wilcox Boilers, 225 HP each, located in the basement; six Armington Sims engines, 125 HP each, direct connected to the armatures of six "Jumbo" dynamos on the floor above; and the necessary piping, pumps and other mechanical apparatus. Two "Jumbo" machines were located in the basement of the southerly building, No. 255. The field resistance boxes of the six dynamos in No. 257 were placed on a shelf near the ceiling of the floor above the engine room; the adjustable dial of each was meshed to a shaft so that all of the fields could be altered by one movement. Individual control of each machine was also possible. Standard pressure was observed by use of the Howell indicator and could be controlled from either of the two floors. The bus bars, of half round coppers, were supported by cleats from the south wall of the engine room, extending from the rear dynamo to near the front window. The dynamo connections to these bus bars were made by a quick operating switch but there was no feeder switchboard, the connection to the feeders being made on one pole through the regular safety catch, and on the other pole by a long copper arm. To connect and disconnect a feeder required the use of an insulated T-wrench to turn the studs in or out. The conductors in the station were sections of standard two-wire underground tubing, supported vertically or horizontally as required, with rigid angle joints from bus bars to and through the vault walls where connection was made with the feeder running to the distant junction box. There were no feeder ammeters, but a needle, held between the arms of a wooden clamp slipped on the conductor, served to give by its deflection an idea of the amount of load being carried by each feeder.

'The rated capacity of each dynamo was in lamps, 1,200 16 candle power. As each lamp (carbon filament) consumed ¾ ampere the rating became 900 amperes for each machine or a total of 6,300 amperes for the seven machines in the

station. The voltage was 110, giving 100 KW each or 700 KW total in the rating now used.

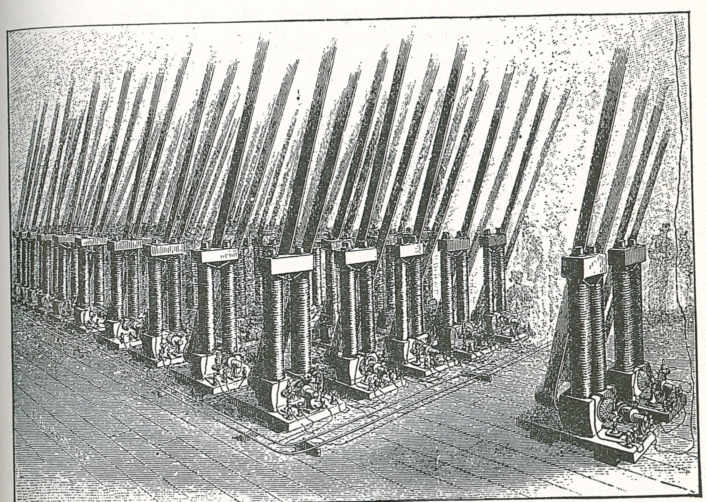
'In Liberty Street, steam was taken from the mains of the Steam Heating Company for two engines which drove, by belts five #20 Edison bipolar dynamos having a total capacity of 2,000 amperes (240 KW) making the combined capacity of the two stations 8,300 amperes or approximately one thousand kilowatts.

'The territory in which the underground feeders and mains were laid was included within the east side of Broadway (although there were a few customers on the west side of Broadway) Park Row, Spruce, Ferry, South, Wall and New Streets. There were connected (April 1, 1887,) 392 customers receiving current through Edison chemical meters, for 13,092 lights, 4 Edison motors and 6 Sprague motors.

'On January 2, 1890, fire wrecked both buildings at 255 and 257 Pearl Street. Of the electrical equipment only one machine was saved. The work of removing the damaged apparatus and the debris was continued without break and on January 12, the old boilers were delivering steam to the engines which were belted to Edison bipolar dynamos. These engines were placed in the basement of No. 255 Pearl Street. There were one Armington Sims engine, 250 HP, one N. J. Safety engine, 250 HP, one N. Y. Safety engine, 200 HP, and one N. Y. Safety engine, 150 HP. There were three dynamos belted to each engine, two on one flywheel and one on the other, there being six No. 32's, five No. 20's, and one No. 16 (added later). The capacity was counted low because full load on each of the dynamos would have been too much for the engine and was taken as 500 amperes for each No. 32 (total, 3,000 amperes), 400 amperes for each No. 20 (total 2,000 amperes) and 320 amperes for the No. 16 making a grand total of 5,320 amperes. A little later the "Jumbo" No. 9 which had survived the fire, having been overhauled, was found to be good for 600 amperes, making the new total of Pearl Street 5,920 amperes as against 6,300 before the fire. During this interval of ten days, the Liberty Street annex was put on as a 24-hour station and carried the load of part of the system.

'The underground system in the First District was wholly two-wire, although the three-wire system was in use from the 39th Street Station which had its first run November 10, 1888, and from the 26th Street Station which had its first run

December 24, 1888. The First District had twenty feeders from Pearl Street and six from Liberty Street, having a total length of 4.67 miles, with 10.93 miles of mains, total 15.6 miles radiating from 75 junction boxes. On April 22, 1890, the work of laying the three-wire system began for an extended First District. By December 31, 1890, the amount laid was 22.8 miles. The new three-wire neither duplicated nor replaced the old two-wire but rather, covered new territory. However, work was started of replacing the old two-wire junction boxes by three-wire, this work being done at such times as were found convenient or as required by new pavement work. The first box was changed in May, 1890, and the final one July 2, 1891, and that there might be something in the way of dividing the load between the two sides of the system as soon as three-wire current become available, the mains along the north curb were connected to the positive and the neutral rings and the mains along the west curb were connected to the neutral and the negative rings. Temporary jumpers connected the positive and the negative rings together. As soon as three-wire current was available in any box the jumper was removed, safety catches placed and the



Edison's first dream of a central station.

installation on one side of the street stood as a rough balance against that on the opposite side.

'The work of reducing the equipment of 255 Pearl Street began January 17, 1893, by sending a No. 32 dynamo to 39th Street Station on February 16, 1893; a No. 16 dynamo was sent to Bergmann & Company, 1st Avenue and 33rd Street on August 31; and September 16, 1893, two other No. 32 dynamos were sent to 39th Street Station. On September 11, 1893, an Armington & Sims 250 HP engine (No. 3) was sent to 39th Street Station.

'On March 4, 1893, the "Jumbo" in 257 Pearl Street delivered current to the system for the last time. The machine was dismantled and sent to Chicago for exhibition in the World's Fair Field in that city. It was exhibited in the World's Fair held in the City of St. Louis in 1904, and was shown in the Grand Central Palace in this city. It is now stored in this city in the custody of the Construction Department of our company.

'On March 12, 1894, two boilers of the Pearl Street equipment were sent to 53rd Street Station. The station delivered current to the system for the last time on June 19, 1894, when it was on from 2:00 to 4:15 PM; on August 28, 1894, the station was disconnected from the system.

'Final regular operating report of 255 and 257 Pearl Street. Week ending March 31, 1894.

Ampere Hours	87,663
HP Hrs. (approx.)	17,533
Engine Hours	17,163
Lbs. Water evaporated	306,250
Tons Coal last report	26
" " received during week	None
" " used during week	26
" " on hand at date	None
Lbs. Coal per HP Hr. (approx.)	3.32
Cost Coal 100 ampere-hours	.08
Labor Total number of men	7
" " wages	112.62
" per 100 ampere-hours	.128
Coal and Labor Total Cost	183.47
" " " per 100 ampere-hours	.209

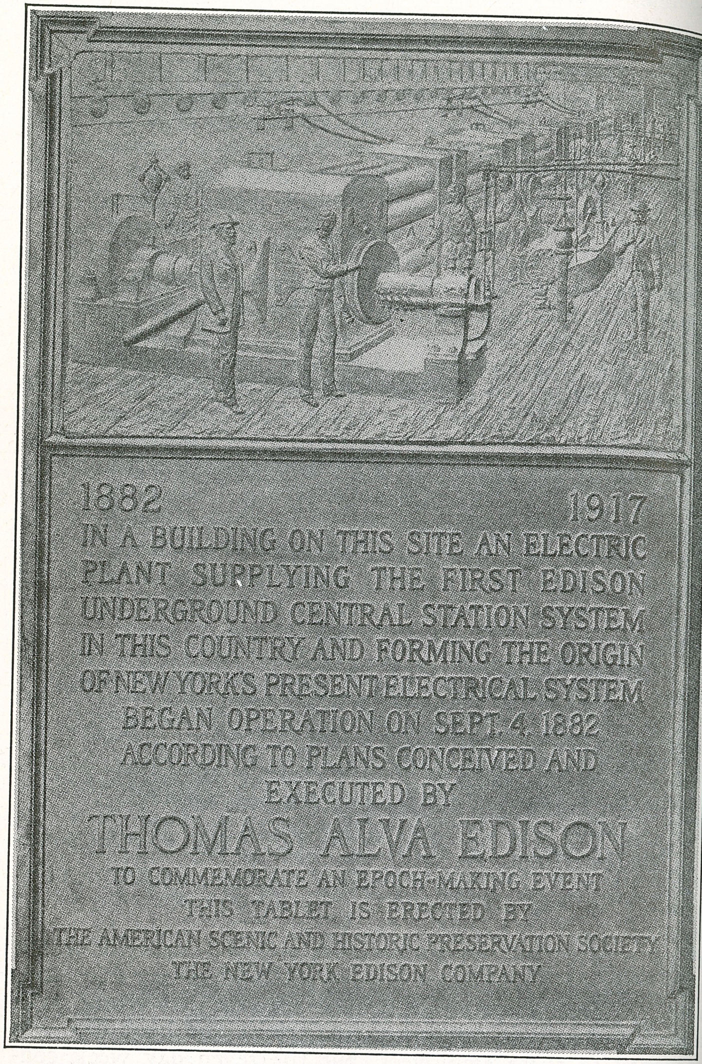
'December 31, 1894, the historic Pearl Street Station has been abandoned and dismantled of its entire equipment and the realty offered for sale. However, there were still honors to be won there for on January 8, 1895, a report to Mr. H. J. Smith, General Superintendent, says, "At 3 o'clock this morning a policeman reported that the water service pipe had burst at 257 Pearl Street. Watchman Thomas McCombs advised me by telephone. He then sent E. de Manderville and the men of the Underground Repair Gang to 257 Pearl Street and with Mr. Silas Fink he went to the City Hall office of the Water Department to get men to help shut off the service. Attempt was made to close the valve in the street but the valve stem broke off before the valve could be completely closed. The valve inside the station (under the water) was finally closed by Mr. Frank Murphy, laborer in the Operating Department and the flood stopped. There was at the time about three feet of water in this cellar and the cellars of 253, 259 and 261 were also flooded. Mr. Wood at once started a gang of men on some hand pumps which he borrowed from Mr. Grady, the district foreman of the Water Department, and the cellars were fairly dry by 3:00 PM." '

The following 'Recollections of Pearl Street Station,' which my friend Donshea once sent to me and which was contained in the *Technical Bulletin* of the New York Edison Company, gives some interesting data relating to the employes at the station and the primitive bookkeeping method used there:

'In a recent article(3) on the Pearl Street Station the physical layout of the station in the year 1884 was sketchily portrayed and it may be of interest to review the personnel, with some of its working conditions and duties, that operated the station and represented at this time the entire payroll of the then Edison Electric Illuminating Company of New York.

'In the generating department the hours of work were eight hours per day and seven days a week. At a later date, about 1887, under a changed administrative head, the hours were changed to twelve a day which resulted in a strike on the part of several of the employees of this department which was defeated by the Company and the twelve hour day maintained. This was continued until 1889 or 1890 when, with another change in administration, the eight hour day was returned to these employees, but the seven day week continued.

(3) Referring to E. A. Harley's article already given.



Tablet on site of original central station.

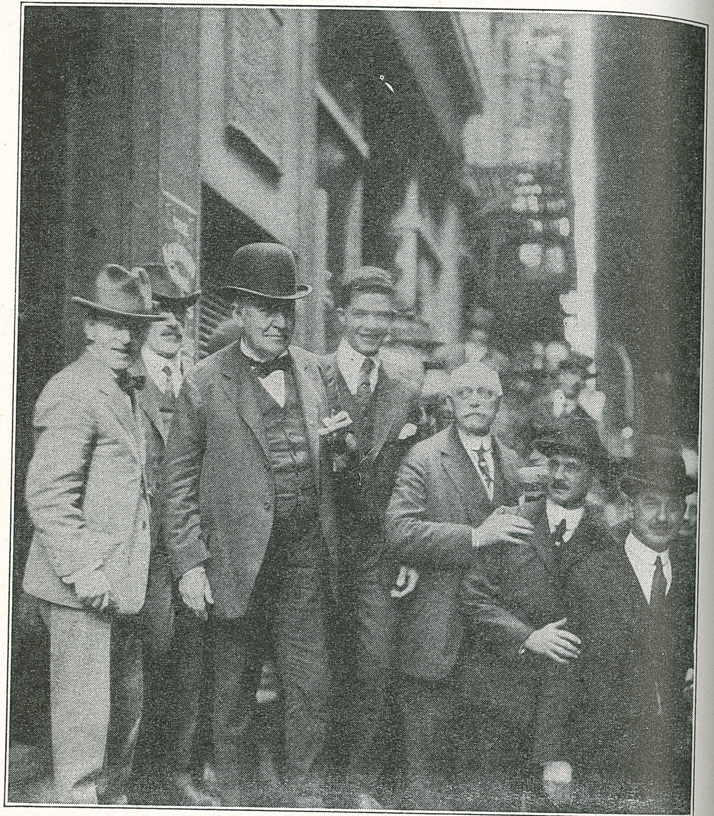
'In this department in 1884 there were one chief engineer, three watch engineers, three oilers, three brushmen and three firemen. There was also one machinist with one helper, the helper being used as a substitute oiler or brushman whenever necessary. The labor force in the boiler room consisted of coal passers who were augmented by additional labor when it was necessary to remove ashes or to receive a delivery of coal. All this labor was supplied by an outside contractor.

'As part of the generating force, but under the supervision of the station electrician, were the regulators. There were two of them, each working twelve hours a day and seven days a week. Their regulating standard was a Thompson galvanometer, and their job was to sit at the desk on which the galvanometer was mounted and note the fluctuations from zero and operate the dynamo rheostat accordingly. This was a monotonous job from which about the only digression was serving the infrequent customer who entered the station for lamp renewals. This condition of employment was changed later by placing a large sprocket wheel on the operating shaft of the rheostats and having on it an endless chain which ran through the floor to the generating room below where the brushman did the regulating from 7 PM to 1 PM the following day. This dispensed entirely with one man and the day regulator was assigned to customer repair work from 7 AM to 1 PM and then worked as a regulator to 7 PM.

'The station electrician was responsible for all the electrical apparatus in the station and was also in charge of the new installation and repair work of the underground system. His most momentous job was the periodical testing of the insulation resistance of the underground feeders. This, with the apparatus then in use, took considerable time and for some reason which now cannot be accounted for, the results were eagerly awaited by all the employees and freely commented on after they were received.

'The short circuits on the underground system, while infrequent, were heavy when a feeder was involved. With no ammeter on the feeders, the feeder in trouble could not be readily located unless the fuse catch blew out. It was a regular practice when a short circuit was on the system for some of the employees to leave the station and walk the streets of the route of the feeders to look for smoke issuing from between the paving stones, and help was occasionally re-

ceived by outsiders coming to the station and stating where they had seen smoke come from the street. After a short circuit was cleared by burning it off and the feeder in trouble identified, the first thing that the underground men did was to walk over the route of the feeder to discover, if possible, a sooty deposit on the edges of the paving stones which would locate the point of the trouble. If not successful in locating



Picture taken at the site of the Pearl Street Central Station during the dedication of the plaque. The dark streak shown at upper right is the shadow of the elevated railroad. Left to right—Wm. H. Meadowcroft, Wilson S. Howell, Thomas A. Edison, ———, T. Commerford Martin, Samuel G. Rhodes and Richard Darlington.

it, the cut and test method would be followed until the fault was located.

'The underground force consisted of four men, two on the day force from 7 AM to 6 PM and two at night for the remainder of the time to cover the twenty-four hour day. The night men, as noted in the previous article, slept on the premises and could be called out for any day emergency. The laboring force for this work was supplied by a contractor to the number desired. If an emergency arose during the night, which made it necessary to have additional labor, it was the job of someone in the station, who could be detached from his work, to go up to Cherry Hill, and, through alleyways and dark hallways, find the men desired.

'The meter department consisted of two men and a part-time boy. The meters used on the customers' installations were the original Edison chemical meter and at this time there were about four hundred and fifty installed in the district. This number made it necessary to change the bottles in from fifteen to twenty meters a day. The meters were in sizes of 12, 25, 50 and 100 light capacity, each size using a pair of bottles of a different size.

'One of the men in this department was in charge and did most of the inside work which consisted of weighing the plates and recording the weight of the plates for the outgoing bottles, weighing the plates from the incoming bottles and calculating the difference between the two recorded weights. It was the daily task of the Superintendent of the District to examine the results and by use of a constant to convert the weight difference to the amount of the bill to be rendered to the customer.

'The other man in the department, accompanied by the boy, would start out early in the morning, carrying in baskets, the bottles to be changed that day. If they had as many as four of the largest size meters (100 light) to change in one day, it was considered one of the few heavy days of the month. After changing a sufficient number of bottles to fill one basket, the boy was sent back to the station and he was kept busy the balance of the morning in scraping the excess deposit off the used plates and coating the plates with mercury after which they were placed in a drying closet. When dried, the loose mercury on the plates was scraped off and they were then ready to be weighed and assembled in the meter bottles.

'The second man, after completing the route, would return

to the station and in disassembling the incoming bottles would affix the meter number to the plates for identification and the plates then would be placed in the drying closet and weighed the following morning. During the afternoon the bottles for the route on the following day would be assembled and frequently it would be necessary to mix a new supply of sulphate of zinc solution that was the liquid in the bottles.

'The service maintenance man, known as the repair man, attended the customers' service complaints and made the necessary replacements of plug fuses and lamp sockets. The standard wiring installation at this time was of the exposed type, held in place by wooden cleats. There were some installations where the wiring was fastened to porcelain knob insulators. Although the cut-outs, plugs and interior of the sockets were wood, trouble, other than blown fuses and defective sockets, was unusual. This repair man also slept on the premises and was expected to respond to calls at all hours.

'The office was manned by three persons and the part-time boy. One was the Superintendent who transacted all the business of the company. He did all the purchasing and it can be said all the selling, as all requests for service had to have his approval before being acted upon. He set the amount of the bill to be rendered to customers and then would call on the customer to defend the amount on the bill if the customer complained of an overcharge. All the company's business except banking the collections was done by him or under his supervision.

'The second man was the collector who delivered the bills to the customers, collecting as much as possible when delivering the bill, as failure to collect meant another visit, for bills of this character were rarely paid by mail. The collector kept the cash book and handled the petty cash. The other man in the office was the bookkeeper who made out the bill forms, kept the customers' ledger, and did the statistical work of the office.'

It may be mentioned that during the remainder of the year, after the station was started in regular operation, no bills were sent out to the customers, and many amusing tales are told of the time when the station began to present bills for current consumed.

In February 1883, the company first began to charge for the current delivered. It was Edison's policy to let his

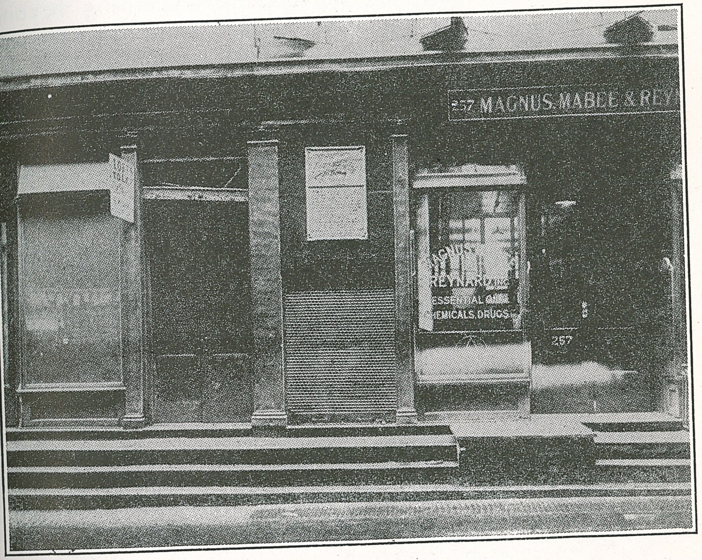
customers get well-acquainted with his system and light and to prove to them, as well as to the world, how convenient and handy it was, how safe and soothing to the eyes. The gaslight in those days was always fluctuating; it tarnished everything; it was dangerous; and it emitted an unpleasant odor.

Edison's light was thus a blessing; yet, the gas companies and others did all they could to discredit it; and at the beginning even scientists and others opposed all that Edison did, and tried to disparage his work and efforts.

The Pearl Street station, however, served to open the eyes of the world, and Edison kept on forging ahead, disregarding all criticism. Some scientists were fair in expressing their opinions, but did not vision the general expansion of Edison's system.

In 1882, Sir William Siemens, in his opening address as president of the British association, said, among other things, the following:

'It can no longer be a matter of reasonable doubt that the



Bronze tablet in position on the site of the Pearl Street Central Station, as viewed from the street.

electric light will take its place as a public illuminant; it will be preferred for certain uses, such as lighting drawing rooms and dining rooms, theatres, concert rooms, museums, churches, warehouses, factories, and also the cabins and engine rooms of passenger stations.

'Whether, however, the electricity can be sent from central stations over a large area to thousands of lamps so that it shall be as unfailing as business requires is something we must await the issue of Mr. Edison's experiment to see determined, at least so far as his system is concerned.'

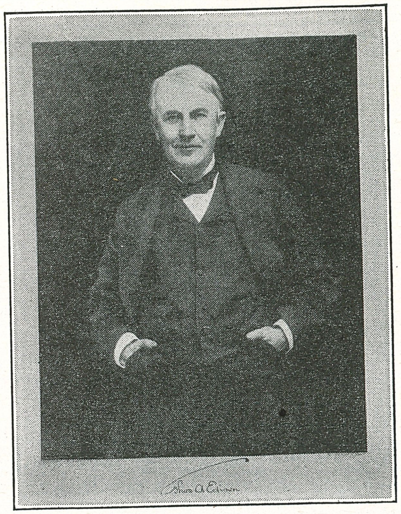
Sir William's doubt vanished long ago, and Edison's system has survived and fulfilled all the expectations in such a manner that even discredit fell upon many of them.

Should you some day stroll along Pearl Street near Fulton Street, you will, no doubt, notice the tablet that commemorates the site where the historic central station once operated. The tablet was erected in 1917 by The American Scenic and Historical Preservation Society and The New York Edison Company.(4)

The Pearl Street Central Station and its aftermath were certainly phenomenal, and universally, something beyond ordinary conception. The Pearl Street Central Station was the progenitor of all that has since been erected, and all the ideas imbedded in Edison's patents on electric distribution fundamentally cover all the systems that have since been established and that are all but by-products of his great and original idea. Edison opened the door for all to expand and to improve.

Edison in later years once said: 'The operation of Pearl Street meant the end of one epoch in civilized life and the beginning of another.'

(4) When I was in New York years ago, I was told that it was Norman Maul, the then editor of *Edison's Weekly*, who first proposed the idea of commemorating 255 and 257 Pearl Street in honor of Edison and his great work there for the advance of civilization.



EDISON, 1904
Autographed picture showing Edison in an interesting pose. Note where the pockets were in those days.

CIII. Sunbury—First Three-wire Central Station

DURING all those days when Edison was engaged in erecting the Pearl Street Central Station and after he started it in practical operation, when he pushed his Thomas A. Edison Construction Company and began to erect the many three-wire central stations commencing with Sunbury, 65 Fifth Avenue remained the Edison headquarters.

The work done at '65' marked the beginning of the practical introduction of Edison's system, and what we know as the electrical industry. Sixty-five Fifth Avenue is a historical spot; it was the birthplace of a new epoch following that of Menlo Park; there, a new turning point in our modern civilization began.

The real 65 Fifth Avenue vanished during the middle of 1886 when the parent Edison company moved downtown,

and the Edison United Manufacturing Company moved in, making it a showroom and salesroom for products of the Edison industries. West Orange, New Jersey, became the Edison headquarters after the early part of 1886, and a new era in Edison's life began. At West Orange he initiated a new series of experiments. Soon he began the erection of a laboratory much more complete and modern than the one at Menlo Park. Despite its completeness, the discoveries, inventions, and revolutionary progress he achieved at Menlo Park have never since been surpassed anywhere, not even by the great American himself.

The establishment of the Pearl Street Central Station was important, for its achievements affected our future progress in industrial development.

What Edison had done gave courage and hope to men. It boosted their self-consciousness, and made them strive forward. Edison brought in the electrical age, with heavy-current industry. Men soon perceived that the future of electricity would be filled with gigantic possibilities, and that other arts, professions, and industries would be so closely affiliated with it that it would be the foster father of them all. Electricity would provide ways and means to enhance other industries, and would accomplish revolutionary changes.

Although elated with the success of the Pearl Street station, Edison knew that something remained to be done to lessen the cost of copper investments in his distribution system. Yes, the two-wire system with feeders was all right, but its area of distribution was not large enough yet to lure many investors. It required more small central stations for a certain area.

Edison had studied the 110-volt system in all its detail, and also the isolated plants that employed only fifty-five volts. So it happened, while constantly thinking on the subject, that he resolved to try a plant employing 330 volts, to connect three lamps in series, and to see what could be done. In such a plant it was interesting to note how the tension of 330 volts would act in practice. Then again, three lamps in series could be of sixteen, ten, or eight candle power; in fact, the three lamps in series could be arranged in some manner that would be satisfactory to the consumer. During the experiment, some other things might turn up. He knew that with 330 volts, his area of distribution would be increased

Office of The Edison Electric Light Company, 65 Fifth Avenue, New York City, 1881. Mr. Edison is seen at the left grasping the handrail; Mr. Charles Batchelor, center; and Major S. B. Eaton, president of the company, at the right.

greatly and his copper investments likewise would be diminished.

These questions had already been thoroughly studied at Menlo Park by Edison and Upton, and doubtless often recurred to the former while the erection plans of the Pearl Street Central Station were in progress.

For Edison it meant continual investigation and experiment, and out of it evolved the system still in vogue today. When asked why he experimented so much, he replied: ‘It is the only way to find out if anything will work.’

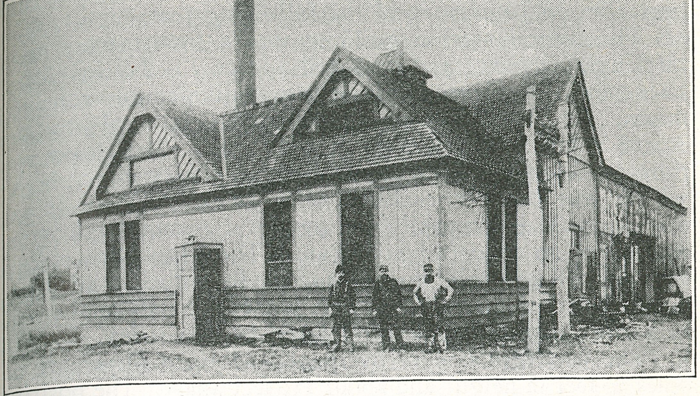
The Roselle, 330-volt, village central station was erected, it was said, to provide cheap illumination for small country villages, with an exceptional saving of copper in the distribution system. The following article was once written by me for the *Edison Monthly* about the Roselle plant:

‘The world's first commercial central station erected on Pearl Street, New York, in 1881-82 on the basis of Edison's 110-volt tension at the lamps and with a two-wire main and feeder distribution system has often been discussed or referred to in these articles. Also the lighting plants first to be installed on the S. S. *City of Worcester* and other vessels with a voltage of 55 at the lamps have been described. But another unique plant erected at Roselle, New Jersey, in 1883, is not so well known, perhaps, although it is of almost equal historic interest.

‘This plant, like the one on Pearl Street, New York City, had a two-wire system of distribution, but it was operated at a voltage of 330 volts. Of course, this tension necessitated the employment of three lamps in series and if the switch was turned on or off, the three lamps either all lit up together or were extinguished, as no other practical means could exist to operate them separately.

‘The Edison Electric Light Company and the Edison company for isolated lighting jointly met the cost of $25,000 for the erection of this plant. It was an experimental central station to demonstrate the possibilities of illuminating small towns and villages where the buildings were scattered, and to do so by employing a distribution system requiring a minimum investment in copper.

‘In most of the residences in Roselle at that time one lamp was mounted on the front porch, and in series with this a second lamp was installed in the lower hall and a third one in the second floor hall. As the dining room and parlor were



A 330-volt central station erected by Edison at Roselle Park, New Jersey, and placed in operation on January 19, 1883.

generally on the same floor, they were either lighted by a cluster of three lamps or the three lamps were divided according to the requirements, with taps from a series leading to the kitchen or bedroom or both. It should not be forgotten that people in those days were not accustomed to the brilliant lighting of the present time, but were more than satisfied in at last having a light that was steady and free from all the disadvantages of candles and oil lamps. Consequently, the good citizens of Roselle were quite willing to forego the individual control of their lamps and were content with the idea of three lamps on or off at the same time. They were induced into this very amiable frame of mind at the very outset by the fact that they received the wiring of their homes free. Then the cost of the current was very low because of the experimental nature of this whole system. Incidentally, however, although built for the purpose of conducting tests, it nevertheless continued in successful operation for nearly ten years.

‘The Edison company for isolated lighting was started in 1881 and Mr. Miller F. Moore was its first general manager. He resided then at Roselle. In 1882, Edison asked him to try to obtain from his village authorities the permit and franchise for erecting a central station plant there, and this he succeeded in doing. Moore commenced the work of installing it toward

the latter part of 1882, and it was completed and put into operation on January 19 of the following year.

'The central station building was a frame structure of pleasing appearance and measured 39 feet 7 inches by 34 feet 10 inches in the clear. Its interior was divided into compartments; the boiler room which measured 15¾ x 39½ and the engine room which was 19 x 39½ feet. The steam was provided by a 150-horsepower Marvin duplex safety boiler which was entirely enclosed with brickwork, while the machinery had a capacity for four K dynamos, each to be driven by an independent engine. The plant was started with three K 330-volt dynamos and ran from dusk to midnight as was usual in many of the first plants in small towns, and as is the custom in some rural districts even today.

'The conductors were overhead and were suspended on poles 30 feet in height and about 130 feet apart. The positive wires, where there were more than two, were placed on the upper arms, and the negative on the lower. In those streets where there were only two mains, the positive ran on the right side going from the station, and the negative on the left. The total length of wire installed was nearly nine miles.

'This station was located at the corner of First Avenue and Locust Street, and from there a feeder ran to the centre of distribution. Even the lamps used in the plant itself were not taken from the "bus," but from a main that ran back from the distribution centre. At the start there were about forty houses wired and nearly 600 lamps connected to the system, of which 150 lamps served for street lighting. There were fifty lamp posts each holding a cluster of three lamps. The platform of the railway station was lighted with nine lamps in clusters of three, while the waiting rooms each had a three-light electrolier. The lamps in the telegraph and ticket office were in a portable fixture and a wall bracket. S. Bergmann & Company supplied all such accessories as the lamp sockets, switches, and electroliers.

'Among some of the other buildings to be lighted were a church, a hotel, and a few stores.

'Roselle had a population at that time of about 2,000 and has gone down in history as the first village in the world to possess the Edison incandescent electric street lighting.

'Mr. Moore was assisted by Mr. Wilson S. Howell, electrical engineer, in finishing the electrical part of the Roselle plant. After Howell left, Mr. Oakley succeeded him. Although Mr. Moore himself resigned his position with the Edison interests in the latter part of 1883, his name is always remembered with a feeling of great respect by the "old boys," for they recall his connection with steam engineering—connections which brought to Mr. Edison's attention the value of the Armington & Sims engine which he adopted early in the history of Edison lighting. It was Moore, too, who assisted Edison in the construction of his later type of electric locomotive.

'The association of Moore with Edison goes back to 1881 when the inventor was in need of an active manager for his isolated plant department and he heard through Mr. Bernard of Moore's capabilities as engineer for high speed steam engines.

'Edison had Mr. Charles L. Clarke, the chief engineer of the Edison Electric Light Company, see Mr. Moore for the purpose of arranging an appointment with him. When Moore came to Edison, the latter offered him the position of general manager. Moore at first suggested that some other man who was in need of a job be afforded the opportunity, as he was well situated and contented in the one he already held. To this Edison replied, "I don't want a man who has no job. I want a man who has a good job and I want to offer him a better one." '

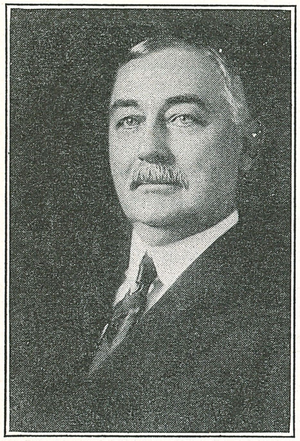
And it happened, as it had happened before—while Edison's mind was constantly engaged in picturing his 330-volt station and he was turning his visional kaleidoscope—that he saw something that gave a sudden jolt to him . . . (I explained it in Volume II, pages 824 and 825.)

In the vernacular of old Menlo Park days, Edison wondered why he had not 'tumbled' over it before. He had found what others had thought once impossible; he had found a method of saving copper and yet having every lamp, motor, or unit of current consumption independent from each other.

What he saw was the three-wire system. What he must do next was erect a station and prove it in reality! Yes, a station as he had seen it in his visional kaleidoscope.

It, of course, took some time to get the station going, as I have explained in Volume III, page 937.

The Edison Electric Light Company and the Edison company for isolated lighting were not disposed to put up the cash for this experiment, as they had done for the Roselle project. He did not let this stop him, for he had more faith



P. B. SHAW
An active Edison representative in Pennsylvania and Ohio, where he organized many Edison illuminating companies using the three-wire system.

than ever in the new conception of current distribution. That was why he started his own company; that is, the Thomas A. Edison Construction Company, about which I have already told you. He would build a small central station as cheaply as possible, and convince the doubters that his system could be enhanced tenfold. To do that, all that was necessary was to show that the copper investment for distribution would be immensely reduced.

In looking for a small town, he thought of a place where fuel—that is, coal—was nearby and where illuminating gas was high-priced. Among towns mentioned to Edison was one called Sunbury, in Pennsylvania. Situated in the coal belt where the gas price for illumination was high—$10 a thousand cubic feet—it was a picturesque town on the Susquehanna River, occupying the site of the famous frontier stronghold, Fort Augusta. Sunbury seemed suitable in other ways, also. Thus this little town became one of the important places at that period in Edisonian history. Indeed, it was a turning point in the future of the new illuminant. The fact that the first plant for the distribution of electricity by the three-wire system was erected at Sunbury put the town on the world's map—like the little hamlet of Menlo Park.

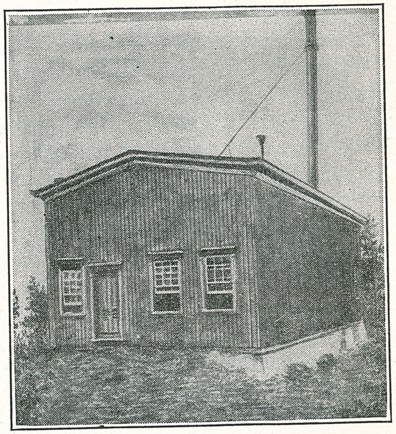
Edison became acquainted with a Mr. P. B. Shaw(1) during 1883, and intrusted him with the work of organizing a local company. Shaw resided a short distance away at Williamsport. From the residents of Sunbury he secured but $700. The rest of the necessary capital he managed to obtain in his home town. Shaw then organized the Edison Electric

(1) Mr. Shaw also organized companies at Williamsport, Shamokin, Bellefonte, Mount Carmel, and Hazleton, all of which central stations were erected with the three-wire system. In fact, the three wire system was soon being employed everywhere.
The Thomas A. Edison Construction Company surely set things going, and I may mention that there were already some twenty Edison stations in successful operation in 1884.

Illuminating Company of Sunbury, and its first board of directors was composed of P. B. Shaw; Dr. T. C. Detwiler; S. T. McCormick and F. H. McCormick, of Williamsport; Lewis Dewart, of Sunbury; Frank S. Marr, of Lewisburg; and Thomas A. Edison, of New York. F. H. McCormick was elected president; Frank S. Marr, secretary and treasurer; and Edison, chief mechanical and electrical engineer. From the roster of past presidents and officers of the Association of Edison Illuminating Companies, I find that Frank S. Marr, of Sunbury, became secretary, and Westley Auten, of Sunbury, treasurer of the association, when it was formed in 1884.

When Edison had finished his plans for installing the plant, he sent William S. Andrews and Lieutenant F. J. Sprague on July 2 to attend to its erection and to get it ready by July 4. The former was to supervise the electrical matter, and the latter, the steam engineering part, while a Mr. Kirby, of Sunbury—later titled 'wire chief'—assisted in wiring. On the working staff at the time were William W. Bateman and Sydney Bateman, both of Sunbury, and a night watchman, 'Cal' Kelly. William was the engineer and Sydney was the meterman and electrician. It must be mentioned that Sunbury was the second point where Edison installed his electrolytic meters; they were first used in New York City.

Some years ago, Dr. Sydney Bateman came to the Menlo Park laboratory in Greenfield Village and visited with me. He mentioned that he had studied medicine later and had practiced it in Philadelphia, Pennsylvania. He was now living at Santa Monica, California. While we were recalling those early days, he mentioned how Edison had written instructions for those who were to manage the station after Andrews. He sat in that little station on



Exterior view of the first three-wire system at Sunbury, Pennsylvania in 1883.

July 8, 1883, and it was far past midnight when the great man had finished them. We must thank Andrews for these original instructions in the Edison handwriting—for preserving them and later donating them to the library in the Engineering Societies Building, 33 West Thirty-ninth Street, New York, New York.

The work at Sunbury progressed rapidly, beginning with the erection of a one-story frame building having an approximate area of 30 x 80 feet, a few feet east of and facing on Fourth Street, since called Vine Street. The building was divided into an engine and dynamo room, and a room for the boiler; later, a small office and meter room were added.

The steam plant consisted of a high-speed Armington & Sims engine having two flywheels, and to each was belted an 'L' Edison dynamo. At that period the 'L' dynamo had a capacity of 150, 16-candle-power bamboo filament lamps, thus giving a capacity of 300 lamps to the station. Steam was supplied by a Babcock & Wilcox boiler. The dynamos for the first time in actual practice were connected in series, and the three conductors were led to simple bus bars, made by straightening some No. 000 copper wire. These were fastened to the wooden wall (we were told in those days that wood was a very good insulator) of the station with iron staples, without any pretense of special insulation, and as Andrews expressed it: 'It was thought at that time that this was exactly the right thing to do.'

The indicating instruments were of the crudest construction, hurriedly designed by Charles L. Clarke and as hurriedly made by Sigmund Bergmann & Company. They consisted of two voltmeters (if it is permitted to call them so), and they were connected by pressure wires to the center of electrical distribution; likewise an ammeter (as we called it) was interpolated in the middle or neutral bus to indicate when the load was out of balance. Together with a half dozen roughly made plug switches, these constituted the world's first three-wire station's switchboard.

In connection with each dynamo there was, of course, an Edison resistance box for regulating the field of each dynamo when necessary. The system of distribution, mains, and feeders were all overhead and on poles.

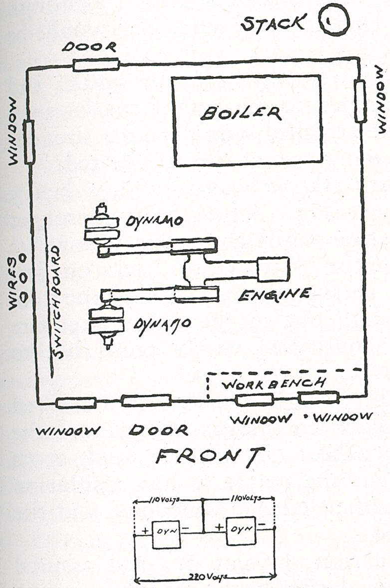
One of the special features of the little station was a glass compartment, or office, where the station attendants sought protection from lightning when a storm came up.

The Sunbury plant was finished on July 3, 1883, and a trial test was made during the night. In the excitement, Sprague was said to have forgotten to put oil into a sight-feed oiler, and the babbitt bearings burnt out. Thus the enthusiasm of all was chilled for the time. Andrews, being a good machinist, succeeded by hard work in getting everything in running order before the next morning. One can imagine how Edison felt during the delay.

On the Fourth of July (1883), the plant was formally started for commercial service by Edison himself. He remained for sometime afterward to study it and to advise of its operation.

While final preparations were being made to switch on the current, it was found that the dynamos refused to pick up, and things began to look blue. Edison, the best trouble shooter in those days, soon found out where 'the bug' was, and the lamps started to glow.

At that moment the three-wire system stepped out of the realm of speculation and opened the road for the future.



Rough sketch of interior of Sunbury central station, as approved by Frank J. Sprague in 1934. The electrical connections of a three-wire station are shown in lower sketch.

It was a double Fourth of July for Sunbury. Excitement ran high that night. The City Hotel and the station were the two points on which the attention of the crowd was focused, and curiosity was soon overwhelmed by surprise and awe at the radiance of the new soft light.

Another important electrical item was that this plant supplied current for two arc lamps that were being tried out on the porch of the City Hotel. In 1883, there was no idea of employing arc lamps on an incandescent circuit, for arc lamps were not

a product of Edison's, although he had patents on an arc lamp of his own. I remember that experiment; in it, the upper carbon was kept revolving.

When Edison was asked about the lighting business, he replied: 'My greatest trouble will be to get the people to use the light.' In fact, some of the people at Sunbury feared that the current would 'leap the wires and burn their houses down' or that 'it was inspired by evil spirits,' and they wanted nothing to do with it.

The following episode is from Andrews, and tells of those days at Sunbury:

'At this time (1883) no such fittings as "fixture insulators" were known, and it was common practice to fasten electric wires to the outside of gas fixtures with tape or string and connect with sockets, which were screwed to attachments held in place under the gas burners. Rubber insulated wire was unknown, cotton covered wire soaked in paraffin or coated with white lead being all that was available. The latter was commonly termed "Underwriters' wire," although it was occasionally called "Undertakers' wire," by would-be humorists.

'The insulation of these wires was naturally weak, and it was no uncommon occurrence to see bright sparks snap between a gas fixture and the attached wire during a thunder storm, to the astonishment and alarm of the uninitiated.

'Shortly after the Sunbury station was started, a heavy thunder storm occurred one evening. A breathless messenger rushed into the lighting station while the storm was at its height, and gasped out that the "City Hotel" was on fire. Naturally I lost no time in getting there. I found the proprietor and his guests standing out in the street, exposure to the pouring rain being considered vastly preferable to being burnt up by electricity.

'Going into the hotel office, bright sparks were observed at short intervals snapping between the gas fixtures and the electric wires. One or two "short circuits" at weak spots had "blown" a few fuses, but the points of low insulation being thus eliminated, no further damage was done, and the snappy sparks were harmless.

'After taking in the situation, I went out and assured the crowd that there was no danger to be feared from the electric sparks around the fixtures, so with some trepidation a few of the bolder spirits ventured into the hotel. Some

explanations naturally were requested, and in order to restore a measure of public confidence in the electric wiring, which was naturally blamed for the scare, I had to strain my conscience to some extent in stating that the hotel had certainly been struck by lightning, and that in all probability it would have been burnt to the ground had it not been protected by the electric wires which provided an easy passage for the lightning to the ground.

'The incident was reported to Mr. Edison, and it led to the invention of "insulating joints," by our late lamented friend, Mr. Luther Stieringer. These joints, being screwed between the grounded pipes and the gas or electric fixtures, prevent the leakage which so much alarmed our friends in Sunbury. In various shapes and sizes, but with no important improvements, these insulating joints are still universally employed, their use being stringently enforced by the National Board of Underwriters.'

About two years ago, I happened to stop at Sunbury, and there I met Mr. Harry L. Keefer, who is regarded by the Sunburians as the Edison Historian of Sunbury. Mr. Keefer is one of the founders of the Thomas A. Edison Science Club of Sunbury, and he was commissioned to go to West Orange in 1922, and to invite Edison to be present at the dedication of the memorial tablet.

Edison accepted, and when the time came some months later, he and his son, Theodore, set out from home by auto. Words cannot describe the ovation and reception.

When Edison asked how often such celebrations were held, and was told every fifty years, he replied, 'All right, I will be here for the next one.'

Edison's indomitable drive was next centered on another town where he might try out his three-wire system with his *underground conductors*. He knew just where to erect such a station. In February 1883, an Edison company had been organized in Brockton, Massachusetts, and it had not yet begun the work of erecting its station. I may mention that Henry Villard had married the daughter of William Lloyd Garrison, the abolitionist, and this relationship came of use to Edison in the erection of the station in Brockton.

Edison remained at Sunbury more than a week, studying his three-wire system in actual practice. The following, in his handwriting, are his first points to be observed by future station managers:

1 July 8/83

Instructions

Sparking of Dynamo

Causes —

1 Brushes not set on the neutral point

2nd One or more of the commutator bars have raised up

3rd Rough Commutator

4th Bad ends on brushes whole of the brush not touching commutator

5th Grooved commutator worn by brushes or sparking continuously from one part of the brush

6th Brushes not opposite each other.

7th Brushes pressing against commutator too lighty

8th Brushes stick in holder

9th Little ring of fire running around end of Commutator

2

To fix the

1st – Move the arm carrying the brushes back or forward until you reach the point where there is no sparking this will be the neutral point with the load then connected

2nd File down the bar or bars with care so as not to file a flat place on bars not high, the high bars will be easily found by one edge being roughened by the sparking more than the others, also you can see & feel the high bar or bars, one ~~sing~~ single high bar will knock & vibrate the brush making a spark & owing to high speed of revolution the sparking will appear as if on all the bars.

3rd Smooth the Commutator by the

(3)

finest sand paper polishing with well worn sand paper – do not use Emery paper

4th The brushes if there has been any sparking should be taken out every day and dressed up for the nights run, by setting brushes properly & keeping them in the neutral point so as to have scarcely any sparking. the commutator will polish nicely & brushes will run for weeks, but sparking cuts & roughens the commutator as well as the brushes, hence if it occurs it will require attention constantly The neutral or non sparking point changes with the load of lamps with scarcely any load on ~~machines~~ the brushes will down on the side of the Commutator as the load

4

Increases the neutral point will shift in the direction of rotation until with full load the brushes will be advanced way up near the top of the Commutator.

5th Every 2 or 3 days set the brushholder piece along the brushholding bar connected to the arm and thus change the position of the Ends of the brushes resting on the Commutator by thus shifting you will be enabled to prevent the formation of grooves by allowing the brushes to run in one rut too long & thus wear down the Commutator Evenly over the Entire surface.

5

6th It is essential that there should be the same number of commutator blocks between each brush if there were 40 blocks for instance & the brushes were 2 blocks wide each you should so set the brushes that you could count 18 blocks on the commutator from brush to brush on either side around the commutator. If this is not attended to & one brush is nearer to the other one way around the commutator than around the other way, it will be difficult to get both brushes in the nonsparking or neutral point for when one brush is in

6

the neutral point the other will be out.

7th The pressure of brushes against the commutator should be as light as will permit the current being taken off with sparking any excess of pressure will only help wear the brushes & commutator out, Sometimes a high bar will knock the brush having a light pressure so badly that until the high bar can be fixed a heavy pressure will for the time being is necessary

8th Sometimes especially when the holder gets hot, expansion & at other times burnt oil etc will cause brushholder

7

to stick — when the brush sticks
the brush itself will in little
while ~~just~~ leave the commutator
making no contact with it
yet be so close to it that it
appears to be in contact &
working all right if you
should lift the other brush
it would open the main circuit
& make an ugly spark always
try the brushes before starting
to see they work freely in the
holder

After a station is loaded
up with ~~all~~ nearly the lamps that
was originally intended the
speed of the Dynamo may be
insufficient to give the
requisite pressure to the Current

8

to bring the lamps up to
their proper candle power
when this occurs & it is
found with the load on
that the Engine is going at
her regular speed & the
regulator is so turned to
get the greatest pressure
that the pressure falls
short the speed of the Engine
can be increased just sufficient
to obtain the right pressure
The pressure increases with
the speed of the Dynamo
while the Current depends
on the number of lamps
burning.

9

Lamps =

The test lamps are defective lamps of which there are a percentage made at the lamp factory they are suitable for testing purposes and they should not be run to as high Candle power as regular lamps so as to make them last as long as possible; they Cost 25 cents The Regular 10 candle lamp cost 60 Cents, the 16 candle, 40c

An account of lamps out lamps in stock and broken Lamps returned from Customers must be kept, ~~Every~~ so that over any period you can tell how

10

many lamps were used as broken at the Central station people are liable to steal the lamps hence you should keep your lamp account well up —

All service wires running from the mains into the Consumers house must be run with insulated wire and placed at least 2 feet apart so that in the most violent wind storm they Cannot blow together

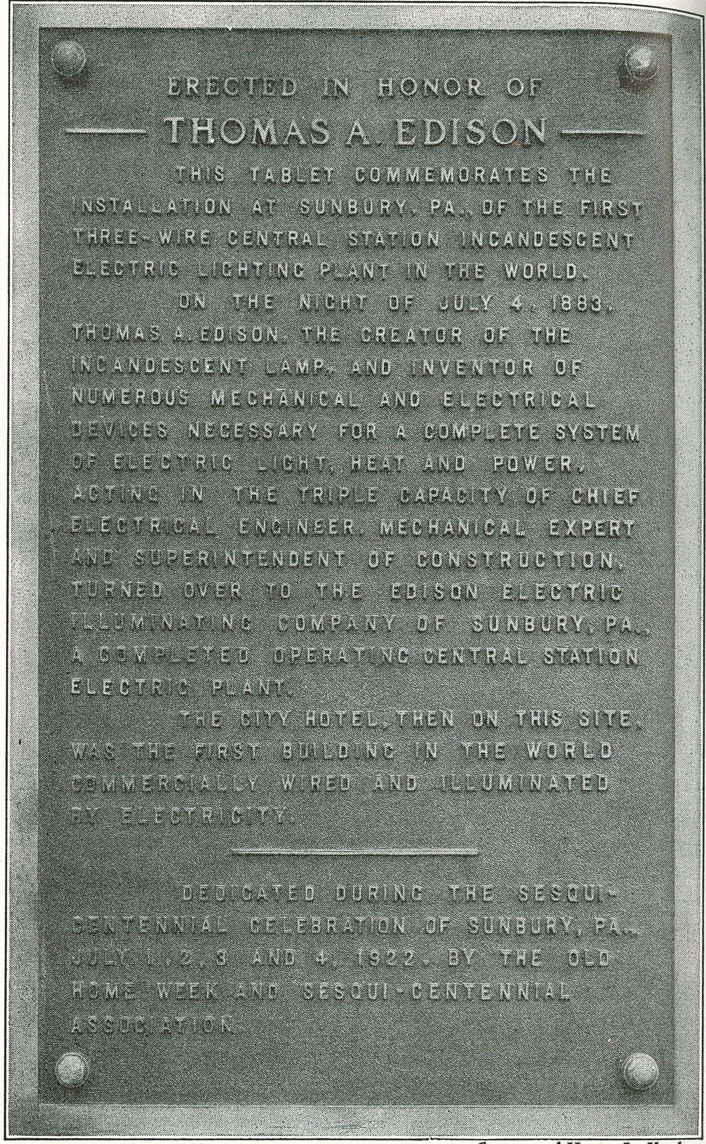
11

With the 3 wire system
perfection of working would
be attained when the customers
were so placed on the A
or B side that there was
an equal number of lamps
on both sides burning
In starting the consumers
are so connected that it
is expected that there will
be an even number but after a
while it is noticed that the
B side has a greater number
of lights than the A which
is ascertained by the deflection
of the amperemeter to the
right or left the next
Customer can be connected
on the A side & by
adding customers to the

12

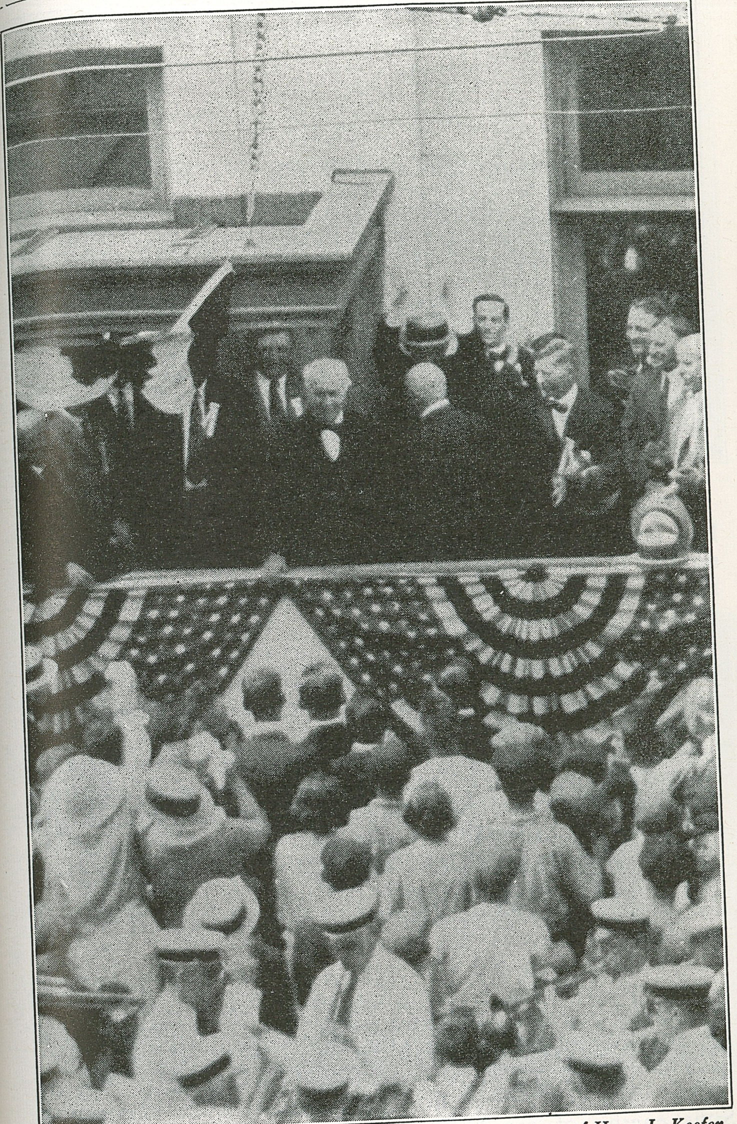
A side as balance is soon
attained when there is an exactly
the same number of lights on
the A & B sides the ampere
meter at the station will
stand at Zero. 0. Some of
the heaviest Customers
should have 3 wire
service lines in their
premises & be provided
with a switch so that
when you are badly out
of balance the customer
can quickly be thrown over
from one side or the other
4 or 5 such customer will
be suffient to effect a
balance when badly out
if the town is small

Thos A Edison



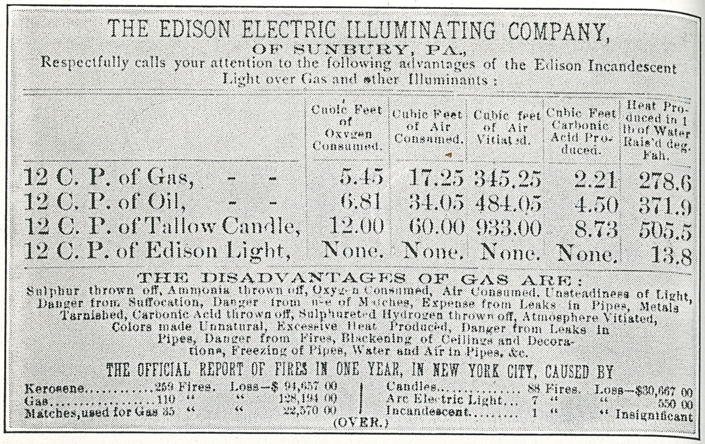
—*Courtesy of Harry L. Keefer.*

Memorial tablet in front of the City Hotel (now Edison Hotel) at Sunbury, Pennsylvania.



—*Courtesy of Harry L. Keefer.*

Demonstration before the City Hotel at Sunbury, Pennsylvania, on July 1, 1892, at the unveiling of the memorial tablet in honor of Edison.



THE EDISON ELECTRIC ILLUMINATING COMPANY,
OF SUNBURY, PA.,
Respectfully calls your attention to the following advantages of the Edison Incandescent Light over Gas and other Illuminants:

	Cubic Feet of Oxygen Consumed.	Cubic Feet of Air Consumed.	Cubic feet of Air Vitiated.	Cubic Feet Carbonic Acid Produced.	Heat Produced in 1 lb of Water Rais'd deg. Fah.
12 C. P. of Gas, - -	5.45	17.25	345.25	2.21	278.6
12 C. P. of Oil, - -	6.81	34.05	484.05	4.50	371.9
12 C. P. of Tallow Candle,	12.00	60.00	933.00	8.73	505.5
12 C. P. of Edison Light,	None.	None.	None.	None.	13.8

THE DISADVANTAGES OF GAS ARE:
Sulphur thrown off, Ammonia thrown off, Oxygen Consumed, Air Consumed, Unsteadiness of Light, Danger from Suffocation, Danger from use of Matches, Expense from Leaks in Pipes, Metals Tarnished, Carbonic Acid thrown off, Sulphureted Hydrogen thrown off, Atmosphere Vitiated, Colors made Unnatural, Excessive Heat Produced, Danger from Leaks in Pipes, Danger from Fires, Blackening of Ceilings and Decorations, Freezing of Pipes, Water and Air in Pipes, &c.

THE OFFICIAL REPORT OF FIRES IN ONE YEAR, IN NEW YORK CITY, CAUSED BY

Kerosene...........	259 Fires.	Loss—$ 94,657 00	Candles..............	88 Fires.	Loss—$30,667 00
Gas..................	110 "	" 128,194 00	Arc Electric Light...	7 "	" 550 00
Matches, used for Gas	35 "	" 22,570 00	Incandescent.........	1 "	" Insignificant

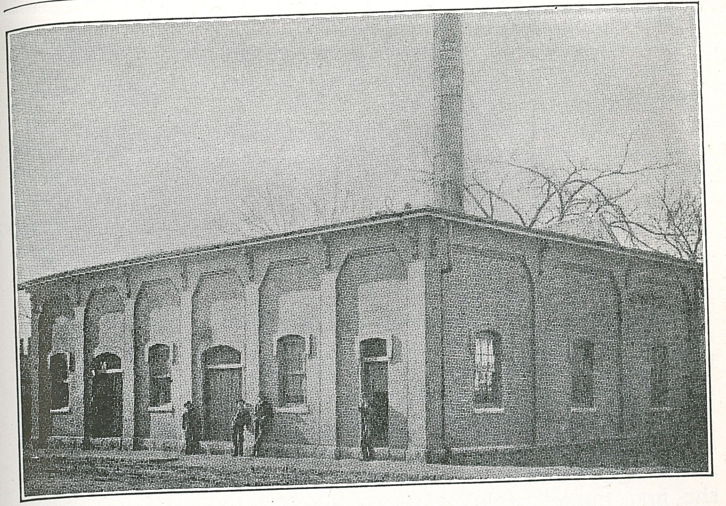
(OVER.)

Competitive advertisement about 1886.

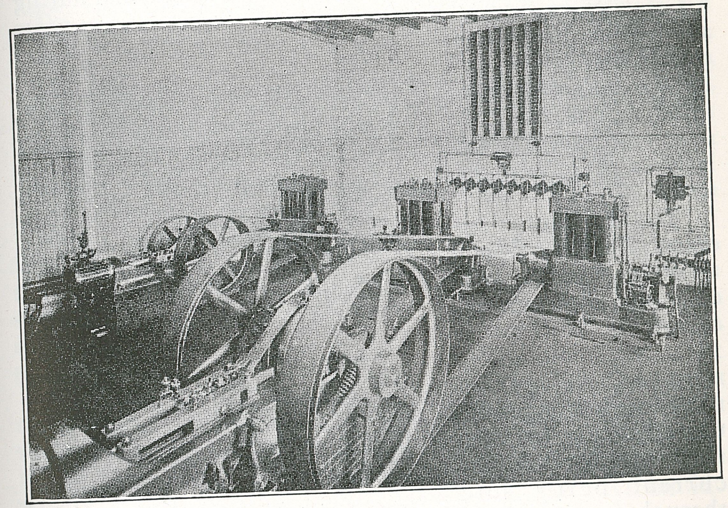
The Edison Electric Illuminating Company of Brockton had been organized by William Lloyd Garrison, Jr., and a number of his financial friends, with the object of organizing, installing, and operating central-station incandescent lighting plants by the three-wire system. Application had been made by Edison in 1882 for a patent to the system, and it was issued to him in March 1883. The contract first made by the Brockton company with the Edison Electric Light Company contemplated the installation of an overhead pole-line system, but it was found that by reason of many large trees and a public sentiment adverse to overhead lines that would interfere with those trees, an underground tube system was indispensable.

The construction company organized by Mr. Edison to build and to equip central stations took entire charge of the project. Mr. Edison himself attended the formal opening on October 1, 1883. He remained a week in consultation with his engineers and in watching the operation of the first three-wire underground system. It supplied current to about 200 lamps of ten candle power each, and had a capacity of about 1,600 lamps.

The equipment consisted of two Babcock & Wilcox boilers of seventy-three horsepower each; an Armington & Sims engine of 125 horsepower, 14½-by-13-inch cylinder;



Exterior view of Brockton station.



Interior view of Brockton station.

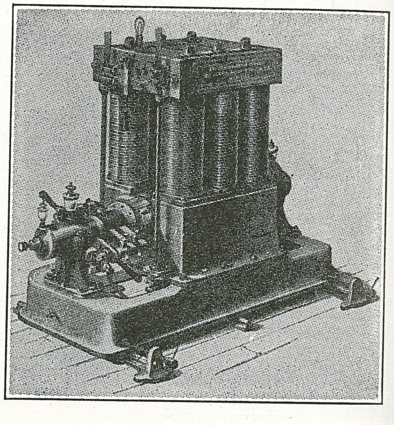
a thirty-five horsepower, 8½-by-10; and three Edison 'H' dynamos, the third dynamo being so arranged by a break-down switch as to supply both sides of the system during light loads.

This arrangement of using one dynamo on both sides was found to interfere with chemical meter registration, the meters on one side of the system registering backward during the hours when this combination was employed. After running an all-night customer having lamps on one side of the system, the company might be found to owe him something for the privilege of supplying current to him. About six months after the starting of the station, when the meter registration assumed permanent importance, the third 'H' dynamo was replaced by two dynamos of the 'S' type, each of 200 lamps capacity.

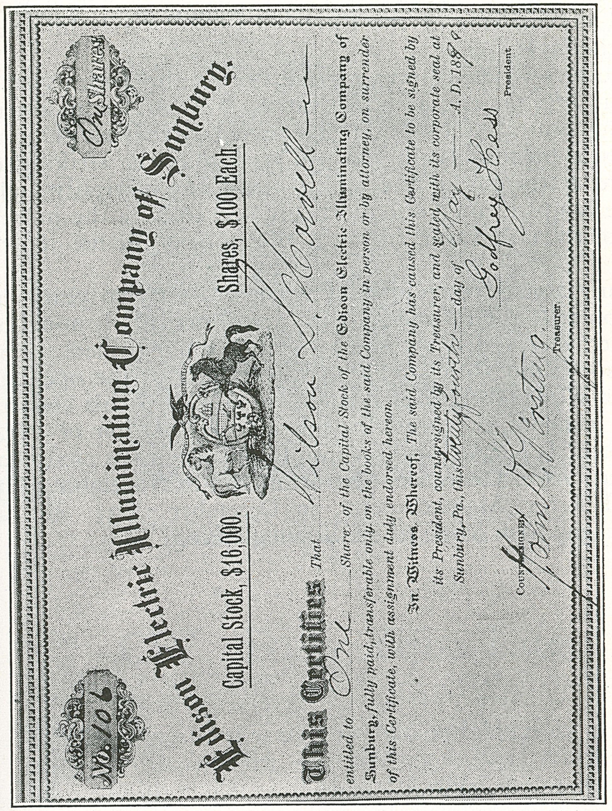
Lieutenant Frank J. Sprague also had a role to play at this plant; he was Mr. Edison's engineer for its installation and early operation. In the office of this station he wound the first model of his railway motor, the ironwork being made according to his plans at a machine shop nearby. Mr. W. J. Jenks was the station manager. He was connected formerly with the telephone company.

H. Ward Leonard was Mr. Edison's meterman, and during his stay of two months or more, made careful experiments and drew deductions that contributed much to the success of the meter practice of the next ten years, particularly in three-wire systems.

The first theater operated from an Edison three-wire (or any other central station) was opened in Brockton in 1884, with an equipment of 500 lamps connected with the distributing mains by two three-wire services, the current being sold through four 100-light



Edison H-type dynamo, 1883. Manufactured at the old Goerck Street shop.



Edison Electric Illuminating Company of Sunbury.

No. 106 — One Share

Capital Stock, $16,000. Shares, $100 Each.

This Certifies That Wilson S. Howell is entitled to One Share of the Capital Stock of the Edison Electric Illuminating Company of Sunbury, fully paid, transferable only on the books of the said Company in person or by attorney, on surrender of this Certificate, with assignment duly endorsed hereon.

In Witness Whereof, The said Company has caused this Certificate to be signed by its President, countersigned by its Treasurer, and sealed with its corporate seal at Sunbury, Pa., this twentyfourth day of May A.D. 1890

Treasurer. President.

Share of the Sunbury stock that Mr. Shaw gave to Wilson S. Howell in 1890 for past services as an expert efficiency engineer.

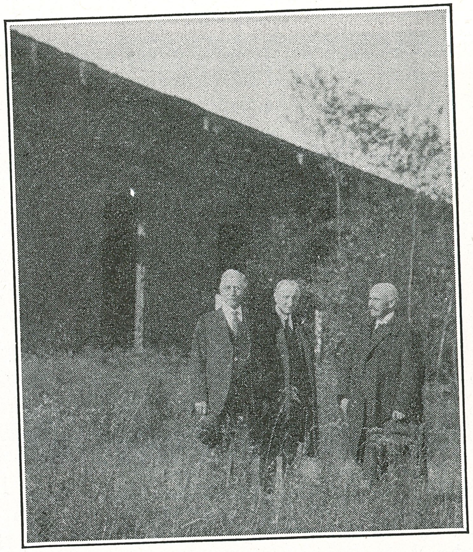
meters connected in multiple arc. The confidence that by that time had been established in the reliability of the light was such that this theater was never piped for gas, and its illumination was entirely satisfactory, even with the small number of lamps installed.

It was first planned by Bergmann & Company to place the fifty-light central fixture in this theater-auditorium on a single main cutout, without branch cutouts in the fixture itself. The suggestions of the late Luther Stieringer, the widely known lighting expert, resulted in the division in the wiring of this fixture so that a separate cutout was pro-

vided for each group of five lamps, twenty of which were placed on one side of the three-wire system and thirty on the other side.

The first residence ever lighted from a three-wire system and the first fire-engine house supplied by any incandescent lighting central station were connected with this plant in 1884, the firehouse being so equipped that the striking of the fire alarm during the night would automatically light all the lamps throughout the house and liberate the horses, thus for the first time assisting in the work of the fire department.

Many attractive features of what was for two years the show plant of the Edison company were particularly noted by a multitude of distinguished visitors, among them being Professor Elihu Thomson, who was present at the opening, and Sir W. H. Preece, of London, who visited this country at the time of the Franklin Institute Exhibition of 1884. The methods pursued in Brockton formed the basis of similar installations in Lawrence, Massachusetts, in November 1883; in Fall River, Massachusetts, in December 1883; and at Newburgh, New York, the following spring.



Three Edison Pioneers—Charles L. Clark,e William S. Andrews, and Francis Jehl—on the site of Menlo Park, 1922.

CIV. Forty Years Later

THE epic of that historic Edison laboratory compound at Menlo Park was not yet finished when I left it in May 1881, as I have described in the last chapter of the second volume of Reminiscences.

After I had passed forty years in Europe in the service of incandescent lighting, I found myself one October day in 1922 once more on the grounds where the laboratory formerly stood. With me were Charles L. Clarke and William S. Andrews, both of whom came down from Schenectady, New York, as Edison Pioneers of Menlo Park, to join in a pilgrimage to the place where we had served so many years ago under the great master.

Menlo Park was deserted, the old brick railway station was gone. A short distance beyond, toward Metuchen, was a small wood structure that served as a flag station.

Upton's house seemed as fresh as ever, while the Davis Inn, once the haven of good old Mackenzie, was gone; and on its site stood a Ceramic Works.

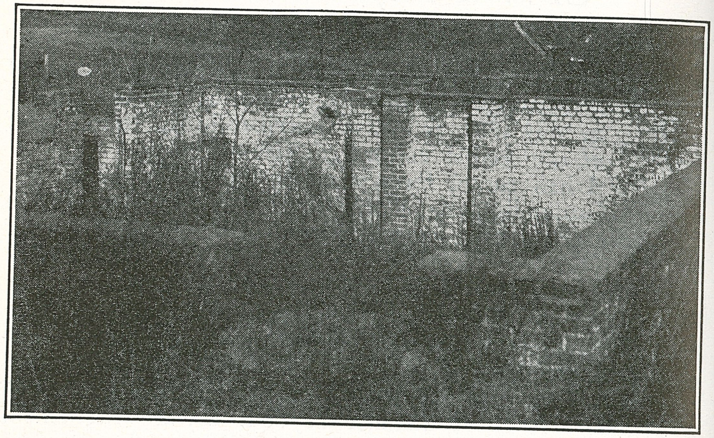
The house(1) in which Batchelor and Kruesi once lived still remained, but it showed the wear and tear of half a century. Nothing remained of the Edison home but its brick foundation. I was told that on July 5, 1917, the house was struck by lightning and burnt.

It seemed ironical that the house of the man who had harnessed electricity should be destroyed by the very element that he trained to be a servant. The Jordan Boarding House, where many of the laboratory 'boys' once boarded, and the house next to it, where Dean lived and Clarke roomed, still stood.

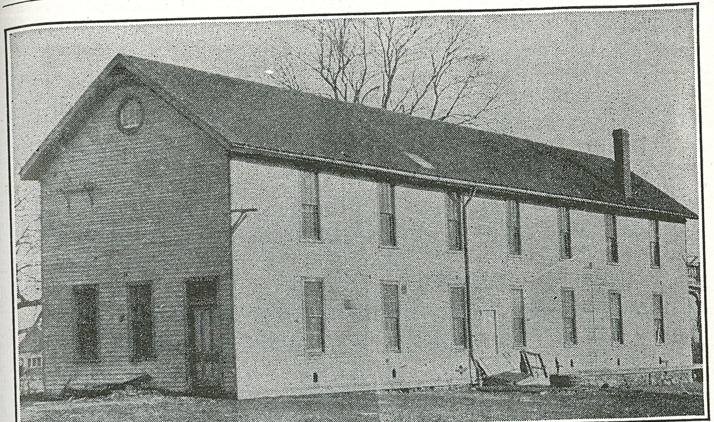
Going diagonally across and up the road, we entered the rectangle where the Edison compound had been. What a vista of desolation and chaos it presented! It seemed incredible. The very spot where Edison and his laboratory were immortalized; where his genius had wrought wonders, whose impress will ever remain on all nations of the world!

Seeing the destruction that had taken place during these years, I realized the loss to posterity. No monument could supplant the mysticism of that laboratory, where he once labored and where his pleasant smile and genial manner

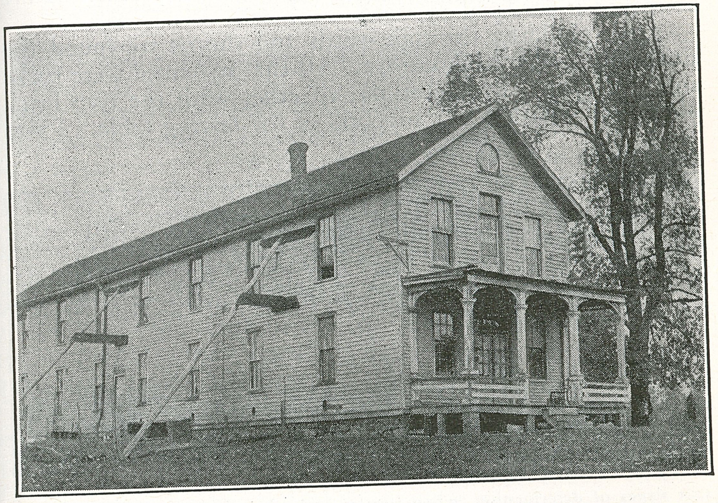
(1) See Vol. I, *Menlo Park Reminiscences*, p. 240.



Foundations of the Edison home at Menlo Park, as they appeared in 1922.



The original laboratory at Menlo Park, as it appeared a few years after the inventor moved to West Orange.



A few years later. Note props to support a side wall of laboratory.

were always like a benediction to those about him.

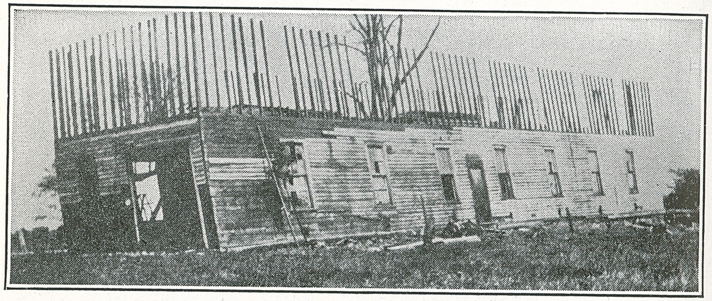
Seeing how great was the obliteration, I reflected on man's forgetfulness, especially on the part of those who profited so bounteously from his great work here. I turned to Clarke and asked why no one among the leaders had ever thought of preserving the place.

He replied that Lieb had suggested such an idea some time ago, but when he approached some of the others, they simply put their hands into their trouser pockets, shrugged their shoulders, and said: 'What's the use? There's no money in it.'

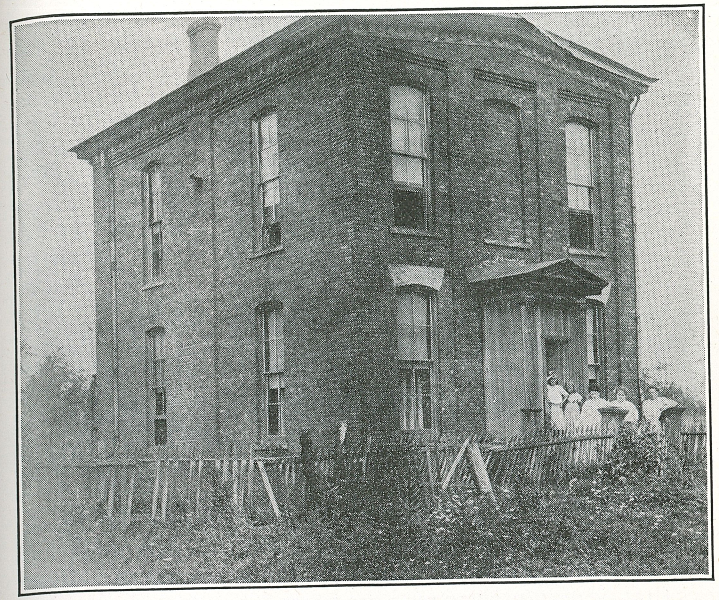
'Well,' I answered, 'perhaps someday someone will come along who has sentiment, even if he is not an Edison man of Menlo Park or 65 Fifth Avenue days.'

Then we walked to the site of the office building, of which only the foundation was visible. The vault on the north side adjoining the office building, where Edison used to store his most important papers and other valuable objects, was bare; it almost appeared as if an aerial bombing raid had taken place. I was told that after Edison had abandoned the office building, it was used as a Sunday school and that the Reverend Hubert Roche of St. Luke's Church, Metuchen, came on Sunday afternoons to instruct the children who lived at Menlo Park. Later, a family occupied it as a home. A fire destroyed it on April 13, 1919.

After plodding through weeds and thorns we found the site of our beloved laboratory. All that remained were rocks and bricks of the foundations, together with the two brick piers that served as the supports of the testing table. I was



Last stages of deterioration, when farmers and others began to tear off boards from the old laboratory and to use them for various purposes.



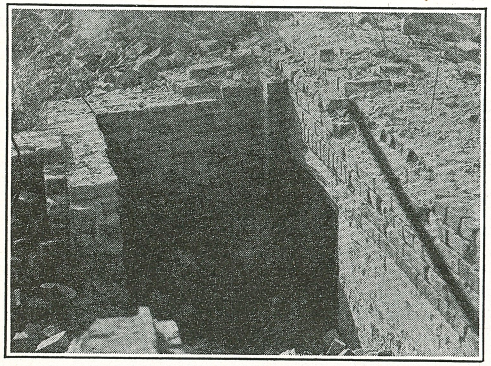
During the period when a family lived in the Edison office building at Menlo Park

touched when I saw them; and sadness filled my mind.

I was told that the old laboratory had been used as the meeting place for Hussey's brass band, and that even dances were held there on special occasions. A stage was improvised and entertainments given, the audience consisting of the folks living at and near Menlo Park.(2)

Afterward the laboratory was used by a chicken farmer. The chickens, however, did not prosper for it seemed that the ground was soaked with different chemicals, particularly with plenty of mercury—dating back to the time when we were working with the mercury vacuum pumps and chemicals were often spilled. When the chicken farmer moved, the grand old place was left to itself. Once, when a strong wind blew, it rocked considerably and was in danger of tumbling over. Some charitable soul who no doubt had a streak of respect and reverence for what Edison had done there, propped it up and it was saved for the time. After

(2) I have already referred to Hussey as a good talker and 'tall' storyteller.

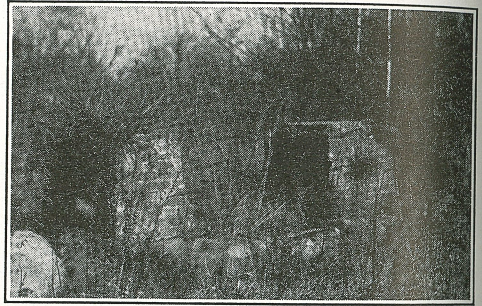


Foundations of the office building.

that it became a source of secondhand lumber for residents of Menlo Park or for those living nearby, when they needed boards for patching barns, shacks, and other buildings. I was told that one man had considered the lumber as having some historical value, and had managed to store quite a pile. What was left of the laboratory blew over during a storm in 1913.

And so the once-famous Edison laboratory of Menlo Park that had passed through such a glorious decennial, had been beset by appalling vicissitudes and subjected to indignities that were enough to rend the heart of any loyal Edisonian.

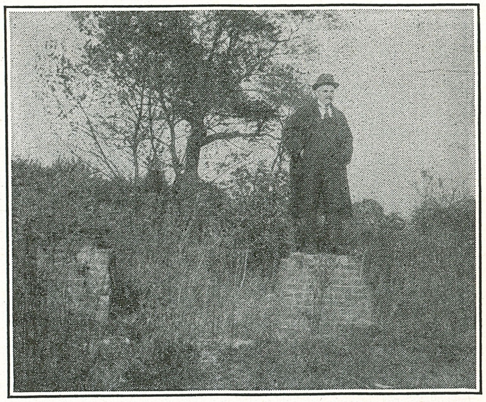
Finally we came to what was once the machine shop, and that too presented a sorry sight. It happened that a man had bought lots 8, 9, and 10—on which the Edison machine shop stood—no doubt for a song, thinking that the bricks of which the shop was built were worth much more than the purchase price. When he attempted to salvage the material he found that the bricks and cement with which the building was built were so rock-hard that



Brick piers of testing table as found at Menlo Park. Now in restored laboratory in Greenfield Village, Dearborn, Michigan.

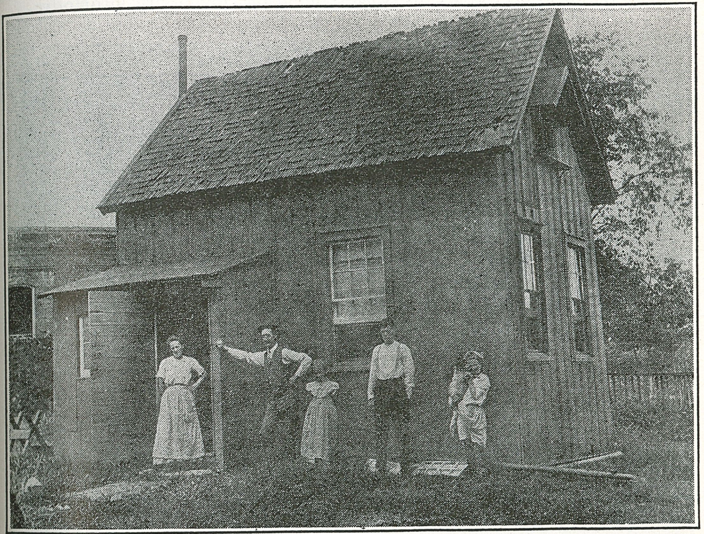
much time, expense, and tedious work would be required to get the bricks out whole.

So disgusted did he become that he stopped work and allowed the shop to stand, as the illustration on page 1128 indicates. It still had its roof and walls, to a certain extent.

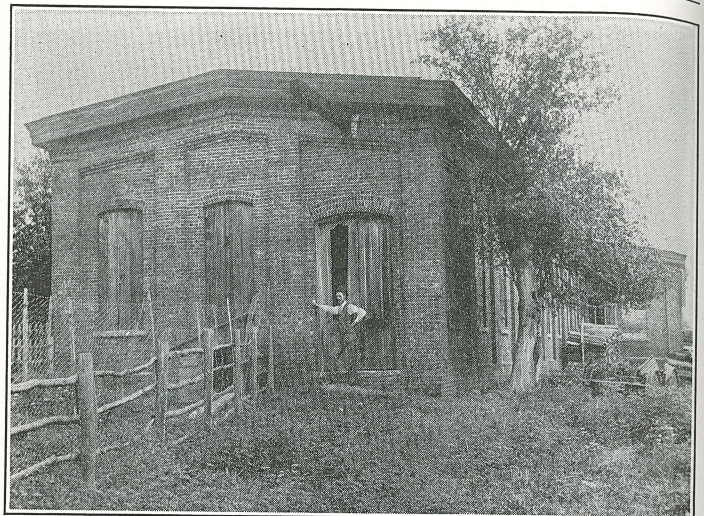


Francis Jehl on one of the testing table piers, 1922.

I may add that the machine shop was so well-built that it would have lasted centuries. At one time the end of the



The McConnel family lived in the Glass House for a time. Later, it was salvaged by the General Electric Company.



When the Menlo Park machine shop served as a chicken coop and cow barn. Just visible by the tree are the remains of Edison's old electric locomotive.

machine shop facing toward Christie Street was used as the depot of the Menlo Park Hook and Ladder Company; while the other end served as a cow barn and chicken coop, kept by Thomas J. McConnel, a farmer.

I may mention that McConnel occupied the machine shop before it had been bought for its bricks. The family lived in the Little Glass House, where the first glass bulbs were blown by our glass blower, Boehm.

A cow, some sheep, and a pig comprised his livestock, and his chicken yard was fenced off in the front of the machine shop.

The Little Glass House was salvaged by the General Electric Company, and that company preserved it at its employes' recreation grounds in New Jersey. Later, it was presented to The Edison Institute to complete the compound in Dearborn,(3) as I have already related.

(3) I may state that the General Electric Company, successor of the Edison General Electric Company, Edison Machine Works, Edison Lamp Works, and Bergmann & Company, respectively, has always upheld the Edisonian traditions. The blood that was infused into the company in 1892—new men at the helm—proved one of the most beneficial blessings in the history of the electrical art and industry, as these men established for the future, on more meritorious and active basis, the great work of Edison.

Three Edison Pioneers—left to right: William J. Hammer, Alexander Mungle and Francis Jehl—on the site of the original Menlo Park laboratory, 1928.

When we were about to leave, I told my friends to take a last look at the waste. I hoped the place was not dead, and predicted that it might live beyond the most sanguine expectations of all of us. I quoted the words of Mark Antony, 'If you have tears, prepare to shed them now.'

* * *

That the aftermath of Menlo Park came as it did, and as I have described above, may have been an exceptional stroke of destiny. One cannot blame the disciples of Menlo Park for the remorse they felt because no enthusiastic Edison Pioneer came forward who was willing to buy the laboratory compound and to preserve it in honor of the man who had paved the way for so many to attain success.

I know that the Menlo Park laboratory 'boys' would have done it, but the vocation of each was to teach and instruct others, and that work kept each one from the more lucrative channels when such were most opportune.

So matters stood for some years. The ruins and ground on which once stood the laboratory, known in every corner of the earth, became the property of Hugo Zimmermann and Joseph Giacomo; Zimmermann possessing lots 6, 7, 11, 12, 13, 14, and 15, and Giacomo lots 8, 9, and 10.

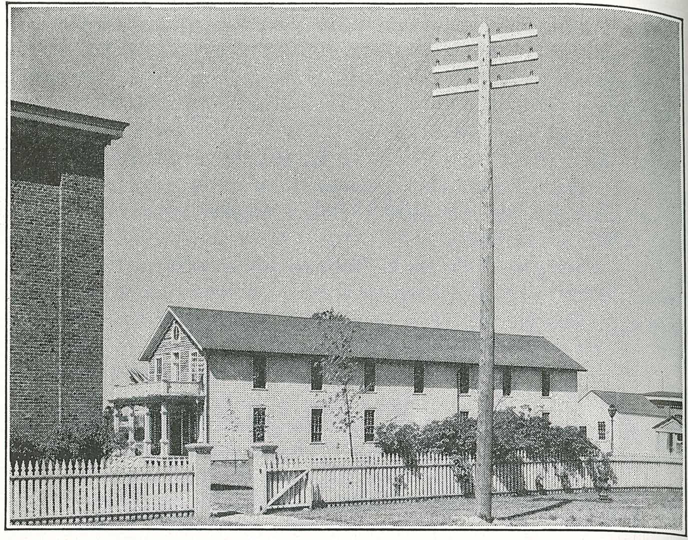
Something happened in the early part of 1928—it was on April 11—that proved a surprise to all. It was whispered about that the Edison lots, as well as other pieces of properties, had quietly been sold. Who had bought them? was the question. All we could learn was that a gentleman of medium height, dark hair, and a congenial manner was the purchaser. Perhaps some more inquisitive ones went to New Brunswick and looked into the records at the County Building, to find that the gentleman's name was Gaston Plantiff. Perhaps the boys sitting around the hamlet's grocery store surmised that he might be a real estate agent or subdivider and that it was about time Menlo Park was picking up, for since Edison had left, nothing had been built but the Ceramic Works.

About a month later—it was on May 7—the deed to the Edison property that this stranger had bought, was again presented at the registration office in the County Building for transfer to another party. The registration clerk took the document and was about to record it when he gave an almost imperceptible start as he noticed the name of Henry Ford.

Soon the news was flashed over the wires, and newspapers made known the identity of the new owner of the old Edison Menlo Park property. Something was in the wind, something was going to happen; and that something was, no doubt, to be a great surprise to all.

At last, the true and loyal Edison Pioneers had found a man of action, one who possessed affection and veneration for the man who not only was his friend, but who also had been his boyhood hero.

And so began the restoration and preservation of this great shrine of Menlo Park—a work that shall prove more important through the ages.



CV. The Final Chapter

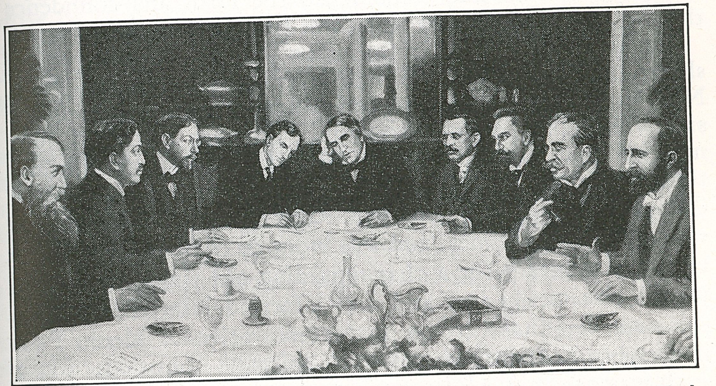
WE NOW come to the final chapter of our reminiscences about the Menlo Park laboratory, and it pertains to the resurrection of that laboratory in all its old-time glory and dignity at Dearborn, Michigan.

This tale is an interwoven one for it takes us back about seventeen years after Edison had invented the lamp, when Edison central stations and plants were flourishing. The year was 1896, and in that year the first race of its kind between electric and gasoline vehicles took place on the track at Narragansett Park, Providence, Rhode Island. There were two electric and five gasoline vehicles entered in the contest and the electric ones won, while the gasoline vehicles could give no account of themselves. Of course central-station men saw in the advent of the electric car a customer that would consume lots of current, all helping to flatten out the peak of the station's load.

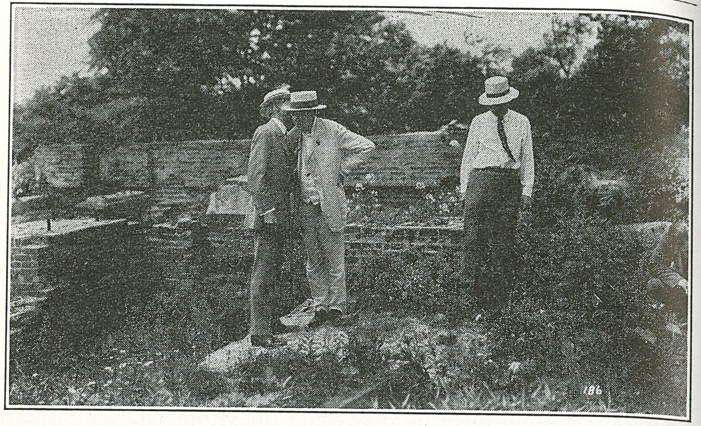
It also happened that the annual convention of the Association of Edison Illuminating Companies that year was held at the Oriental Hotel at Manhattan Beach, New York. From The Edison Illuminating Company of Detroit went three men; one was Alex Dow, general manager and vice-president; another was Hoyt Post, an official; and the third was Henry Ford, chief engineer of the company. He had been working for some years on a horseless vehicle of the gasoline type, and his associates had repeatedly tried to interest him in the coming one, as they thought—the electric one.

At the dinner table where Edison himself sat, station men were debating the prospects of the electric vehicle when Dow, pointing to his chief engineer, exclaimed: 'There's a young fellow who has made a gas car.' One question led to another and Edison became interested so that the young engineer was soon busy in answering questions that the great leader put to him. Then considering the matter Edison gave the verdict, as his fist flew down on the table with a bang. 'Young man, that's the thing, you have it, keep at it.'

It was a significant occasion, for it left an indelible impression on the young progressive mechanic for many years afterward. He said: 'That bang on the table by Edison in 1896 meant worlds to me.'



Scene at dinner of Edison Illuminating Companies at Manhattan Beach, New York, August 11, 1896, as sketched by artist. Left to right the men are Hoyt Post, The Detroit Edison Company; John Van Vleeck, New York Edison Company; Charles L. Edgar, president of Boston Edison Company; Mr. Ford; Mr. Edison; Samuel Insull, Chicago Edison Company; John W. Lieb, Jr., New York Edison Company; John I. Beggs, Cincinnati Edison Company; and Alex Dow, The Detroit Edison Company. Henry Ford is explaining his 'gas' car to Edison.



Henry Ford, Thomas A. Edison, and Charles Edison inspecting the foundations of the Menlo Park Machine Shop in New Jersey before it was shipped to Dearborn, Michigan.

We all know of the success that the young engineer later attained. The time arrived for the realization of an idea he long had cherished—a plan to erect a group of edifices, including the old Menlo Park laboratory, in honor and respect for the man who had emboldened the faith and confidence that he had in himself by just three little words, 'Keep at it.'

Edison promised his co-operation in the restoration of the shrine and the two of them went several times to Menlo Park, New Jersey, to obtain data and other information as to the site where the Edison compound had once stood. I may mention that I personally met Mr. Henry Ford for the first time at the offices of the Association of Edison Illuminating Companies at 40 West Fortieth Street, New York City. He visited us several times, and was wont to come into my office with his secretary for a chat regarding old times or perhaps just to size me up for, as I was informed later, Edison had recommended that I assist in the restoration of Menlo Park in Dearborn, Michigan.

It was natural for Edison to do so, as I was the last survivor of those few who had been constantly employed on the second floor with him on his electric-light work which began in 1878 and ended about 1881.

On another occasion we talked of Edison's first pioneers in

incandescent lighting and those who helped to pave the way for the later workers of Menlo Park. I remarked that Edison was the master and that each one of us was but his disciple to do but his bidding. Those who possessed initiative ability were intrusted with special work at the laboratory, and when all was finished at Menlo Park he selected them again to aid in the introduction of his system here and abroad and to instruct others.

While I was still in New York City I was requested by Mr. Ford to accompany him to Menlo Park where with some of his men he was making excavations. I was surprised to notice that he himself did not hesitate to take up a pick or shovel and help. It was during one of these diggings that he found the pieces of our old mortar which he cemented together and later, when Edison visited the old laboratory in 1929, surprised him by presenting it to him.

In the restored Little Glass House at Dearborn one can see on the shelves the many glass parts of the first lamps that had served Edison in numerous experiments. Likewise, near the east side of the grounds by the hollow where we used to throw all our rubbish, a glass shed has been erected and in it are the scraps and what in the vernacular might be called 'just junk.'

These objects were all brought to light by Mr. Ford while he was engaged in his excavations, and they are considered precious relics, for, as he says, 'Every piece helped Edison in one way or another during the greatest achievements of his career.'

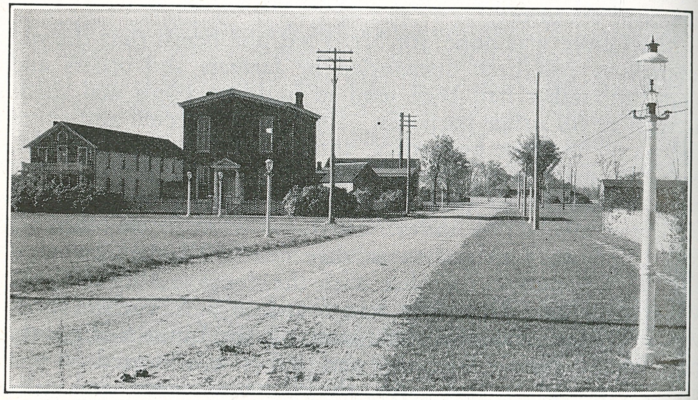
Still more was done, for Mr. Ford had heard that the old laboratory had been dismantled by farmers and others and that the timber had been used in building barns and sheds as well as for other purposes. Some had collected and saved the wood in large quantities, thinking it would, no doubt, bring its price in the future. He started a hunt that would have made G-men proud, and the country around Menlo Park was combed for miles. He found what he was looking for. Yes—he managed to salvage nearly all the timber of the old laboratory, together with the doors and most of the window stiles. One door was found in a Metuchen shop, while another was in a little store on the Lincoln Highway near Menlo Park. Wherever the timber was located, it was either replaced or new barns, sheds, coops, doors, and stiles were substituted.

On the site of the Edison laboratory compound nothing was left undone. Every piece of wood and brick, the foundation stones, and the masonry supports of engines, boiler, and machines were carefully boxed and transported to Dearborn. Added to this the top layer of the very earth—the red clay—was removed from the original site of the compound and shipped to Michigan, thus making the restoration of the Edison laboratory perfect.

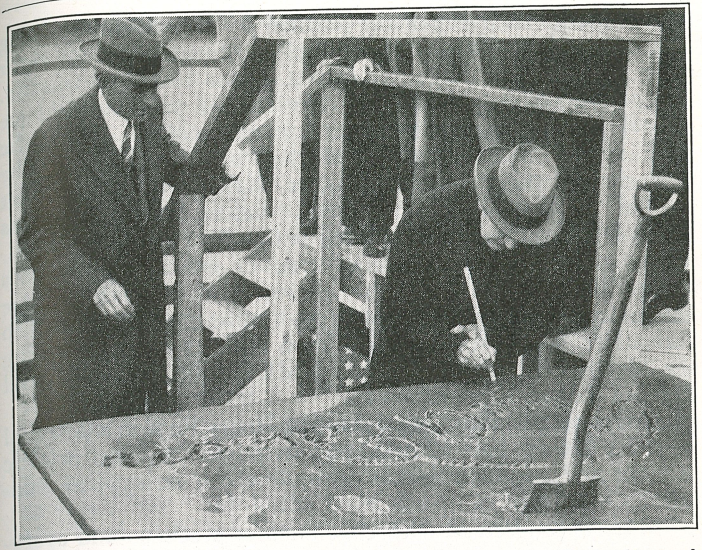
The same happened to the old boarding house where Mrs. Sarah Jordan once formed a link in the course of events that took place at Menlo Park when Edison was there. It too was completely dismantled and transported to Dearborn.

Then came the ceremony of laying the cornerstone of the great Museum that Mr. Ford began to erect in memory of his friend Edison. The day set was September 27, 1928, and Edison, the honored guest, was on hand. The cornerstone, I may say, is of an unusual kind. Today it is already an Edisonian relic. When visitors enter The Edison Institute the first thing they behold is the concrete slab where Edison wrote his name and the date, left his footprints, and thrust Luther Burbank's spade into the concrete for posterity. After the great man passed away on October 18, 1931, this cornerstone became an object of interest and touching memory.

Early in 1929, the restoration of the Menlo Park laboratory



The resurrection of Edison's Menlo Park compound, Dearborn, Michigan, 1929.



Edison inscribing his name, leaving his footprints, and placing Burbank's spade in the wet concrete that forms the cornerstone of The Edison Institute, Dearborn, Michigan, September 27, 1928. To the left is Henry Ford as an interested observer.

and the other buildings of the Edison compound was started in Greenfield Village in Dearborn.

About that same time the Association of Edison Illuminating Companies of Edison, in conjunction with the Edison Pioneers, donated to Mr. Ford its valuable historical Edison collection, commenced by the association back in 1904. Edison, who seconded the donation, also contributed a vast number of relics pertaining to the Menlo Park days.

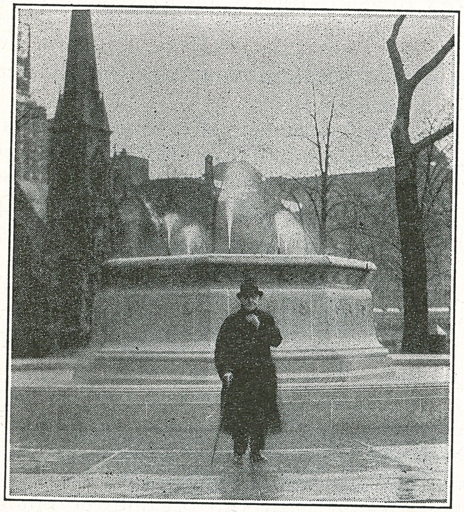
It was Mr. Ford's wish to dedicate the restoration of the Menlo Park laboratory and The Edison Institute on the fiftieth anniversary of the invention of the first practical incandescent lamp; that was on October 21, 1929. For that purpose he paid a visit to the great leader at his Fort Myers home on February 11, 1929, and discussed matters there. Mr. Ford was accompanied by President Hoover, and both Edison and the President promised to take part in the ceremony. As a result, Dearborn became the official locale for Light's Golden Jubilee.

Then something unforeseen happened to me. One night I

was suddenly torn out of my slumber by a most excruciating pain at a nerve near my spine, and it affected also my right hand. The doctor diagnosed it as a sudden attack of neuritis. After giving me a sedative to alleviate the pain, he told me that I should take ultraviolet-ray treatments. With the kind medical and nurse service that was extended by the Electrical Testing Laboratories, a slight improvement set in, but I was still in a bad state. Before I knew it I was whisked off to Detroit and placed in the Henry Ford Hospital. There under the conscientious care of eminent physicians and with the aid of the latest discoveries and advances made in medical science I recuperated to almost my former self in about five or six weeks. I was soon back at work arranging the Menlo Park laboratory as it had been during the fruitful days of Edison's great work.

It was a thrill for me to assist Mr. Henry Ford in a personal way, as I once had Edison, and to notice the enthusiastic interest and unselfish devotion with which he applied himself.

Matters progressed with chronometer precision and everything was ready by October 21. The slogan—'Light's Golden Jubilee'—spread like wildfire, and went around the world. Committees, prominent men, societies, and companies became interested and eager to participate in the movement. It became an international celebration, the like of which had never yet taken place in honor of one man. Men of all colors and races wanted to pay



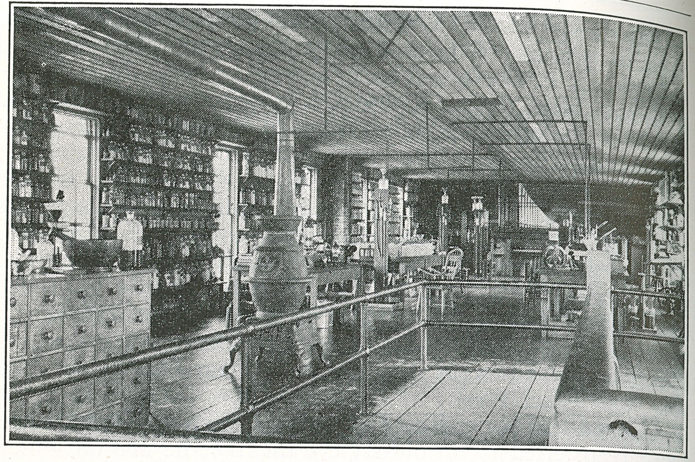
Thomas A. Edison in front of the Edison Electric Fountain in Grand Circus Park, Detroit, Michigan, October 24, 1929.

tribute to Edison. The newspapers of the world daily carried articles on Edison and the memorial that Henry Ford proposed to dedicate to his best friend.

The United States Government issued a special memorial two-cent postage stamp in honor of Edison. In Detroit a memorial fountain was named for him and dedicated in Grand Circus Park. Several streets, schools, and hotels were named in his honor. Then on October 21—Edison Lamp Day—the fame of Light's Golden Jubilee burst out simultaneously around the world. It is not, however, within the scope of my present work to go into the details of what happened everywhere as I desire to give only an account of Edison when he arrived here in Dearborn on October 19, 1929, as the guest of honor of Mr. and Mrs. Henry Ford and their son Mr. Edsel Ford.

Edison and part of his family when they reached Detroit were transferred to an old-style train like the one on which Edison used to sell wares as a candy and news butcher when he was a boy. While the train was proceeding to Dearborn, Mr. Ford took his distinguished guest into the baggage car and showed him the small laboratory with chemicals, the hand press like that on which he used to print the *Herald*, and a basket full of candy and fruit such as he used to sell. When the train arrived at Greenfield Village, all alighted at the Smith's Creek Depot. This was and is the same original railroad depot at which Edison and all his paraphernalia were put off the train because in experimenting with phosphorus he started a fire in one of the cars.

Mr. Ford showed him his old Fort Myers laboratory, and the boarding house of Sarah Jordan. Edison's eyes now began to scintillate, for ahead of him he saw—no, his eyes did not belie him—his Menlo Park laboratory, all so real as though time had swung back for a half century. When Mr. Ford led him through the picket gate by the office building his gaze was centered on the ground—could it be—yes, it was the real red Jersey clay. Looking up, he saw me standing on the laboratory porch. Waving his hand he cried out: 'Hello, Francis,' and I hastened toward him. We entered the old shrine, and the enraptured thrill that he experienced admits of no description. Yet when we had ascended the stairs to the second story he simply stood there for a few moments in dumfounded amazement; his lips quivering seemed to ejaculate a prolonged silent—'Aaa—hhh—!'



Interior of Menlo Park laboratory, as restored at Dearborn, Michigan.

When he had recovered, he walked around; checking some of the chemicals in the bottles, and, finding everything in order and genuine, he passed on and gazed affectionately on the instruments and apparatus with which he had worked. There they were—it seemed hardly possible—all in order and everything as it was in 1879. After he had finished his inspection he patted Mr. Ford on the shoulder and said, 'You have made the place so true that I could not have done better; it is 99.9 per cent perfect.'

When Ford inquired about the tenth of a per cent wanting, he replied with a smile, 'Our floor was never so clean.'

Looking up he saw the old clock we had in the laboratory for checking time experiments. He was puzzled and inquired of Mr. Ford how he obtained it.

'That's a story in itself,' he replied, continuing to relate its tale: 'You see I took Jehl to the Museum and showed him the pile of ancient clocks we had, and after he had carefully examined a certain make he picked out this one made by Seth Thomas of Connecticut.'

'Our clock was also made by Seth Thomas,' Edison replied.

'Yes,' Ford answered. 'And when I checked the history of the clock it was the one I had bought at Milan, Ohio, where you were born.'

'How the old Menlo Park clock got to Milan I can't make out, but it is surely just like the one we used at Menlo Park,' Edison said. He then took a seat in his old chair by the Sprengel air pump. 'It's good to be seated once more in it; it makes me feel fifty years younger,' he said.

They talked about the first successful high resistance lamp that came after months of experiments on October 21, 1879. Mr. Ford questioned him about something and Edison, getting up from the chair, said, 'Let me show you how I used to do it.' He then went over to the chest of drawers and taking a seat in the chair he formerly occupied when he was in Menlo Park, called upon me to get certain kinds of powdered carbon and some liquid hydrocarbon. With these he made a paste and began to knead it into a proper degree of consistency with a spatula, explaining at the same time what he was doing.

'Now, get me a piece of that Clark's thread, Francis,' talking and commanding as he used to do at Menlo Park. Having everything here as we had it in 1879, I got the thread and gave it to him. He began to demonstrate how he once impregnated the raw filaments with a paste just as he had made. He impregnated several such filaments and gave them to Mr. Ford who treasures them as relics and who twined one of these filaments about a thin stick and put it into a glass tube. This tube can be seen on the chest of drawers in the Menlo Park laboratory at Dearborn, Michigan. In fact, Edison arranged the apparatus and other utensils one finds on the chest of drawers, just as he had them in 1879.

It was a pleasure to see how well he enjoyed being again in his old laboratory; he displayed in his talk and actions the spirit of those days in Menlo Park.

Once he took a seat before the Geissler-Sprengel combination air pump and began to evince a sudden peculiar interest in it that prompted Mr. Ford to inquire the cause. 'Some time ago I had an occasion to use a special mercury-sealed stopcock—one like I made at Menlo Park in Jersey—but I could not recall it. Now in studying the old pumps here again, I got it; it's here,' and he showed him the cock. 'That makes me your first scholar here at the institute,' said Edison, and they both laughed over the incident.

In fact, Edison, during his sojourn in Dearborn, came to his old laboratory whenever it was possible. He would sit in his old chair and contemplate; we never disturbed him.

Perhaps his life and what he had achieved at Menlo Park passed before him like a moving picture. In front of him he saw all the apparatus and instruments that he had used when he gave the world the carbon telephone transmitter, the carbon condenser, the dynamic microphone, and so on.

There was his tin-foil phonograph; perhaps he recollected the day when Sarah Bernhardt was there. When he came to the shelves, he gazed at the first Edison Effect Tube and gave an almost imperceptible nod; he had a beatific smile of contentment on his face. On the other shelves were all the trophies that he had won at Menlo Park, and his eyes rambled from one to another. The world had called them wonders and he the wizard. In fact he saw the whole tangible history of his early efforts before him. It must have given him a sublime thrill of satisfaction and assurance that one friend had done what no other of his acquaintances had ever dreamed of doing in so perfect and real a manner. His Creator had blessed and preserved him to live and witness the benefits that his labors had conferred upon mankind.

Now that the great journey of life was nearing its end, it was a comfort to know that the perpetuation of his ideals and exertions were to be continuously realized for posterity and that his memories and spirit could linger here among his former possessions.

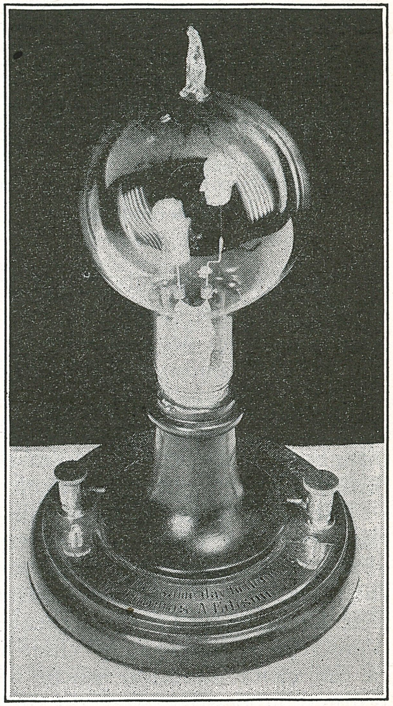
The following incident happened also when Edison was visiting at his old Menlo Park laboratory: It was morning, Edison said to me, 'Let's make one of those cotton filament lamps; I want to give it to Ford as a remembrance of my visit here. I am sure that he will like it and it will give us a little practice so that the lamp that we are going to finish for the celebration will proceed smoothly.'

Accordingly, the lamp was prepared. We had arranged all these details before. In fact we already had an idea of what was going to take place before Edison came, and I had everything prepared. The lamp was soon on the pump and the vacuum on its way. Edison seemed contented when he began to flash the lamp with a little current in order to expel the occluded gases contained in the carbon filament. 'It's going fine, Francis,' said Edison. Everything went in good order and it was wonderful to notice that he had the patience to repeat the tricks that he had used during the old days when the laboratory was in New Jersey.

When Mr. Ford and Mr. Clarke joined us later, an animated

conversation took place that was mixed now and then with an old Edisonian joke. When talking of the glass bulbs he said to us, 'Francis will remember when we began to make the bamboo filaments in 1880. It was necessary to have a longer globe, and I had some samples made in the glass house that were pearlike in shape. The bamboo filaments were much longer than the thread or paper ones we have here, for I wanted to get a higher resistance, thus using a higher voltage.'

Edison continued, 'It occurred to me that these pear-shaped lamps would require more pumping as their cubical contents of air were larger, and that meant that it would take more time to exhaust the air from them. I told Upton about it, and asked him to get me the cubical contents of a round bulb and a pear-shaped one. Well, he took up the matter in a real mathematical way and, after a few hours, I came back to get the figures, but he had not finished yet. I smiled and asked him how it would be if he would fill the bulbs with mercury and then weigh the mercury and, knowing what a cubic centimeter weighs, we would have the answer in a few minutes.'

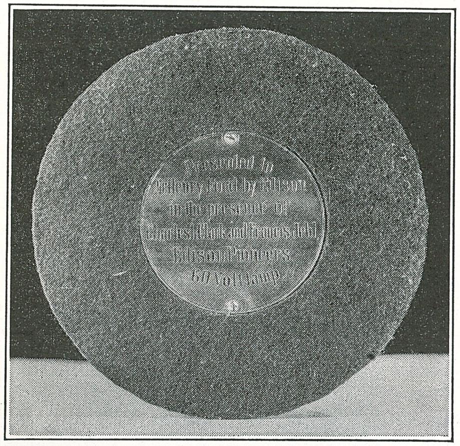


The first lamp that Edison made at his Menlo Park laboratory, Dearborn, Michigan, in 1929 and which he presented to Henry Ford in the presence of Charles L. Clarke and Francis Jehl.

Inscription on the base:

'First lamp made at Dearborn by Thomas A. Edison. October 19, 1929. Presented the same day to Henry Ford by Thomas A. Edison.'

In this manner the time flew; the lamp was finished and then Edison, smiling, bowing, and gesticulating with



On bottom of the base:
'Presented to Henry Ford by Edison in the presence of Charles L. Clark and Francis Jehl, Edison Pioneers, 60 volt lamp.'

his hands, presented it to Mr. Ford in the presence of Clarke and me. This lamp can be seen in the restored Edison Menlo Park laboratory at Greenfield Village, Dearborn.

One day Edison came to his laboratory with Mr. Ford; both took a seat by the old telegraph table at the southeast corner of the laboratory and began to reminisce. The conversation ultimately drifted to Edison's father and the part he took in the building of the laboratory at Menlo Park, in 1876. Mr. Ford then pointed to a board that he had salvaged among the others of the old Menlo Park laboratory and inquired whether he, Edison, had any idea what the inscription on it meant. This board, marked in the manner as merchants used to mark their boxes with ink and brush, bears the jotting—'Menlo Park, December 27, 1876.'

'No, I don't know what this particular date implies, for the laboratory was built and finished in the early part of 1876. Perhaps some man or carpenter was playing with the marking pot,' answered Edison. He continued by adding that he once had three carpenters; one of them lived at Metuchen. Turning in his chair he pointed, as the crow flies, in the exact direction where Metuchen would lie, if the restored laboratory were on the same site it once occupied in New Jersey.

I mention this to show how much Edison felt at home in the restored laboratory. For the moment he even imagined that he was in the old one in New Jersey. Mr. Ford has in his possession the notebook of expenses that Edison's father

incurred when he built the Menlo Park laboratory for his son. Once, while Edison was in the laboratory, he said to Mr. Ford: 'Do you know, I should like to stay here and begin to work again in this old place; it's so homelike, as it was in the old days. There are no frills about it and there is no fuss to it. Ideas come easier in such surroundings and the work goes better when you are at ease in your shirt sleeves without a necktie.'

Mr. Ford told him to stay and promised that everything —men or material—needed for any experiment regardless of how large or small would be supplied. Both then laughed; yet one could sense the feeling that it was partly a wish that Edison meant in earnest. We old-timers knew that Edison loved to work in a congenial place, void of formality and glacial appearance. That was his reason for evincing such an affection for the restored Menlo Park laboratory at Dearborn.

He remembered that he came and went whenever he wished—could dress and deport himself as he felt inclined; in fact, he was as free as a bird without restraint. Undoubtedly, this was one reason for his attaining such magnificent success. I could relate other incidents that took place when Edison was in his laboratory in Dearborn, evidencing the satisfaction and appreciation he felt when amid the apparatus and surroundings of old.

I have already mentioned that Mr. Ford had found the pieces of the old mortar while conducting excavation work on the original site of the laboratory. When he came back to Dearborn he cemented the pieces of the mortar together and one day when Edison came to the laboratory he presented it to him. Edison immediately recognized the mortar and was touched. He said, 'Give it to me Ford, I'll place it here on the chest of drawers where it always stood and where it served us so long and well.' The incident has been commemorated in a poem found in *Menlo Park Reminiscences*.(1)

Edison had a good laugh when Mr. Ford showed him the cubbyhole located under the stairs leading to the second floor of the laboratory. The entrance to it is in the little office at the southeast end of the building. It happened sometimes that when Carman saw an unwelcome visitor coming across the field he would tell Edison, who would then vanish in the cubbyhole. Often he would go into it when

(1) Vol. I, p. 350.

he was meditating, for there he never was interrupted. 'You did not leave anything out I see,' he said smiling. 'You know, Ford, this cubbyhole was a secret, and now you are giving me away,' he jokingly added.

The day before Light's Golden Jubilee Edison told me that we had better prepare for re-enactment the next day of the birth of the lamp. We knew it would take about seven or eight hours to finish one according to the pioneer method of 1879. Hence, on October 20 we drove out the occluded gases and got a good vacuum. In this work I assisted Edison as I had done fifty years before, by keeping the mercury pump running. To replenish the mercury in the reservoir I had to mount a kind of stepladder. Fifty years before I was far more agile than at sixty-nine. Edison seeing me mount said, 'I think it would be good if you would put some sand on those steps, Francis.' I did, for my legs were a little shaky; it certainly prevented me from slipping with twenty pounds of mercury in a glass jar.

Edison prepared the carbonized cotton thread lamp by driving out the occluded gases—getting it ready for the demonstration; the vacuum would be retained to a certain degree by the pump. During the time the work was going on we talked of many things of the past, and how through circumstances we met again to go through the same act as that of fifty years ago. Edison remarked, 'And everything is going on as smoothly as if it were yesterday. You never thought while you were in Europe so many years that a thing like this would ever happen, did you?'

'No,' I answered. 'In fact, the electric-light work in Europe fascinated me and, perhaps, if the Great War had not taken place, I no doubt would still be there.'

Then the talk centered on Mr. Ford and, from what Edison said, I realized that he never suspected anything so complete as that which had been restored at Dearborn.

The next day (October 21, 1929), Light's Golden Jubilee, the whole world rose to acclaim the Wizard of Menlo Park and the success of his labors for mankind. It was celebrated from the Far East to the West; history records no such occurrence where one man had ever received such enthusiastic demonstrations of public esteem, such token of affection and honor, as did Edison. When the sun rose in the East, it was Japan, China, and Java that commenced the celebration, and the special homage they displayed on this occasion was truly

remarkable. I can well assert that the glamour of the Edison festivities in the East vie with those in the Occident.

The same may be said of all Europe, Australia, and South America; everywhere the paean of gratitude could be heard. Sincere eulogistic addresses and newspaper articles on Edison's achievements were signalized in every country. As the shades of darkness followed and as night like the sun also went around the world, electrical displays of every kind were witnessed.

Gorgeous and colorful in effect were the floodlighted buildings with their arches, columns, and colonnades—festooned with myriads of incandescent lamps of different candle power and colors—proclaiming Edison's triumphs at Menlo Park. It was Edison's coronation day and it was solemnized by mankind.

At Dearborn, Michigan, official center of Light's Golden Jubilee celebration, Mr. Ford and his son were busy in welcoming the many notables and distinguished guests. Among the illustrious and brilliant throng were men and women who were peers in science, art, and industry. It is difficult to describe their amazement at what they saw and what Mr. Ford had done. The monumental edifice, The Edison Institute—whose front is an exact reproduction of the Independence Hall, Congress Hall, and the old City Hall of Philadelphia—has all three of its sections linked together in a pleasing colonial fashion. Grand and stately that facade always reminds us of the heroic struggles that our 'do-or-die' forefathers fought in the cause of liberty.

The guests also visited historic Greenfield Village adjoining The Edison Institute. Here they saw in their original environment the pioneer handicrafts in operation and many noteworthy buildings. They saw the little red schoolhouse which Mr. Ford attended, and the Martha-Mary Chapel named in honor of the mothers of Mrs. and Mr. Henry Ford. There was the Menlo Park laboratory, restored so faithfully; it formed an important item in Light's Golden Jubilee celebration.

In the beginning, Mr. Ford placed a group of his brightest boys in the Edison laboratory; they were the pick of his schools in Dearborn and Sudbury, Massachusetts. They began experimenting after the Edison fashion. They progressed admirably and soon the laboratory was too small for the work they were doing. He then had another labora-

tory built for them and equipped it for the special line of research that they were working on. The results have been more than satisfactory.

The Edison Institute and Greenfield Village take up more than 200 acres. It has been founded for educational purposes and for stimulating in youth their creative abilities. Perhaps with all the advantages that these students enjoy, one may some day appear with the qualities of a leader which would repay Mr. Ford for all that he is doing. Thus The Edison Institute is a living shrine, and the spirit of Edison is everywhere. All this came into being because that great broad-minded man encouraged Mr. Ford by just three words: 'KEEP AT IT.'

At The Edison Institute on the evening of October 21, 1929, the Light's Golden Jubilee gala dinner took place. Assembled there were nearly 500 of the world's renowned personalities. On the rostrum sat the miracle man of Menlo Park; while to his right and left were clustered the speakers and other notables.

It was an inspiring picture to behold—perhaps somewhat pathetic. Edison always felt shy on such formal occasions, and this one was one of exceptional brilliancy. The great had come to pay tribute to the great. The whole world took part in it and over the radio was told all that was going on at Dearborn. The radio, telephone, telegraph, cable, and wireless were continuously in action. It was thus no wonder that when that grand old gentleman sensed that he was in the most conspicuous and glaring spotlight of his life, he felt somewhat ill at ease. His deafness may also have contributed to such a feeling. You know how you would have felt under the same circumstances—a battery of eyes all focused on you, lips in motion, but you heard nothing, and all attention directed toward you. Without doubt the telepathic assurances from Edison's good friends about him sustained and eased the situation for him. Knowing him well, I understood how he felt.

Owen D. Young, of the General Electric Company, was the toastmaster at the dinner. In his brilliant introduction he mentioned, among other things, facing Edison, the following:

> It was that vitality of spirit which forced your head to conceive and your hands to execute, which defied sleep as you now defy age, but it did not work alone on your mind and body, and that, I expect, is the secret of your great success. It worked on and through your heart.

> Mr. Edison, as you grew older, and projected that vitality in other fields, great leaders, men, women and children everywhere have been attracted by it. All seek to do you honor. The President of the United States is here. Millions of people, not alone in your own country, but in others, celebrate with you tonight on the radio—and without your lamp as a forerunner, the radio would have been impossible.
>
> Most conspicuous of the men, is our host, Mr. Henry Ford. He has built the Edison Institute of Technology, and this industrial museum in your honor. Other men could have built an institute, but Mr. Ford has done something more.

Then Mr. Young spoke about the action of radium and said,

> No greater honor could be done to Mr. Edison and to this company than to have the presence of Madame Curie.' [Special ovation was given to this frail but great scientific lady.]

Continuing, he added:

> . . . Mr. Ford has brought to Greenfield Village not only every piece of apparatus which Mr. Edison used at Menlo Park, but every chair, brick and stone and even earth, in order that these common things, once exposed to elevating the personality of Thomas A. Edison, may radiate from this museum for generations to come, the vitality of which is his.
>
> What a glorious community! It will light for the future the darkness of the past. I cannot close what I have to say without congratulating Mr. Edsel Ford, joint host with his father on this occasion, on receiving such an inheritance, nor can I omit to congratulate Mr. Henry Ford on having such a worthy trustee to carry on.
>
> And now, ladies and gentlemen everywhere, I welcome you as participants in this celebration, made great because it is the affectionate tribute of one master workman to another, Mr. Henry Ford to Mr. Thomas Edison.

It is needless to add that Owen D. Young's address, of which I have given only excerpts, was several times warmly applauded. Candles illuminated the banquet hall showing that kind of lighting before Edison invented the lamp.

Then Edison, President Herbert C. Hoover, Henry Ford, and my humble self rode from the banquet hall to the old Menlo Park laboratory in Greenfield Village. Outside, the gods of darkness and rain did all they could to spite the man who had turned night into day. We arrived safely, however, and Edison took a seat in his old armchair by the Sprengel air pump. About twenty-five camera newsreel men followed us, and soon the laboratory floor was a tangle of electric-light cables for arc-light projectors. Graham McNamee was at the microphone, placed east of the old organ. President Hoover and Henry Ford stood at Edison's side. The laboratory was lighted with the old fishtail gas burners.

The gas was made, as of old, by a gas outfit located in the carpenter shop at the rear of the laboratory. The light was dim and the whole scene gave a peculiar aspect to this part of the celebration. I received the signal from Edison to begin and soon the old Sprengel pump went into operation. When the desired stage of vacuum was reached, Edison began his work while President Hoover and Mr. Ford watched attentively.

When Edison had finally succeeded in driving out the last of the occluded gases, I was ready to seal the lamp off the pump and put it on its life test, as we had done in '79. In fact, Edison went through all those dramatic manipulations as he had gone through them a half century before. Every action of Edison and those about him was faithfully depicted by McNamee over the radio.

As an interlude let me mention that Charles L. Clarke, who managed in some way to get into the laboratory with the newsreel men, told me afterward that when I took up the blowpipe and alcohol lamp to seal the glow lamp off, Edison got a little uneasy. Many years had passed since I had used the blowpipe for sealing off a lamp from the pump, and I knew that at this critical moment I *must* do it and not *try* to do it, for I comprehended what a flop would mean for me and all. Clarke told me that Edison had raised himself from his chair, balancing himself with both his hands on the chair's arms, and was moving his head to and fro, watching anxiously every step of my operation. When I had finished the sealing off successfully, Edison whispered to me, 'Bully for you, Francis.'

When Edison had finished the lamp the news was immediately flashed over the world and the lights that had been switched off during the re-enactment were now turned on. The replica of the Liberty Bell in the tower of the Independence Hall of The Edison Institute sent out its peals of tidings and as Shakespeare said, 'Give us a light there, ho!' was enacted a second time within half a century.

During all the time that Edison was engaged in the re-enactment of the birth of the lamp he maintained a cool and ordinary disposition in spite of the activities of the newsreel men.

We returned to Independence Hall where the rest of the guests were waiting. Instead of candles, incandescent lamps were now ablaze everywhere; we were in a deluge of light.

Edison, the President, and Mr. Ford were warmly acclaimed when they returned, and the second part of the celebration began.

Mr. Walter S. Barstow, president of the Edison Pioneers, delivered his address, dwelling upon those pioneers who were with Edison in Menlo Park in '79. To Edison he said,

> The value of your contributions to the welfare and comfort of your fellowmen can never be measured . . .
>
> In place of empires you have founded industries which are engaged throughout the world in advancing civilization.

Continuing, he spoke of the Menlo Park site where the laboratory once stood and where the iron lattice tower now stands 100 feet high, having more than 800 lamps at its top formed like a single lamp.

Then came the radio speech of Professor Albert Einstein, from Germany. The following are some of the high points that were flashed across the ocean:

> It is a singular pleasure to me to be able to offer you my heartiest congratulations from so far a distance.
>
> The brain-workers and especially the scientists and technical engineers of the whole world are remembering you and your work today with admiration and sympathy.
>
> The great creators of techniques, among whom you are one of the most successful, have put mankind into a perfectly new situation . . .

Then the great inventor and discoverer, Thomas A. Edison, arose and delivered his speech. A deep silence prevailed; one could see that he was somewhat agitated for as we knew the great man, he was not a talker on formal occasions. He was shy of the mike, although he had invented it in 1877. I may also mention that the radio hookup was the largest in the history of radio broadcasting at that time. With a slight tremor and emotion, the sage of Menlo Park began:

> Mr. President, ladies and gentlemen:
>
> I am told that tonight my voice will reach out to the four corners of the world. It is an unusual opportunity for me to express my deep appreciation and thanks to you all for the countless evidences of your good-will. I thank you from the bottom of my heart.
>
> I would be embarrassed at the honors that are being heaped upon me on this unforgettable night, were it not for the fact that in honoring me you are also honoring that vast army of thinkers and workers of the past and those who will carry on, without whom my work would have gone for nothing.
>
> If I have spurred men to greater efforts, and if our work has widened the

horizon of thousands of men and given even a little measure of happiness in this world, I am content.

This experience makes me realize as never before that Americans are sentimental, and this great event, Light's Golden Jubilee, fills me with gratitude.

I thank our President and you all, and Mr. Henry Ford, words are inadequate to express my feelings. I can only say to you that in the fullest and richest meaning of the term, 'He is my friend.'

Good night.

Just as he finished the 'good night' we saw that he was so overcome with emotion that he suddenly sank down in his chair; all noticed that his nerves had left him for the moment. Kind hands immediately carried him to an adjoining room and placed him on a couch while the President's physician, Dr. Joel T. Boone, attended him. In a little while he recovered and as he saw me standing by the couch, he smiled and said:

'It was nothing but stage fright, Francis.'

According to the program Mr. Ford was to speak after Edison, but as he felt worried about the condition of his friend he excused himself after making the following statement:

There could be no greater satisfaction to me than to aid in paying tribute to Thomas A. Edison, whose remarkable achievements in our lifetime have so materially contributed to the advance of civilization throughout the world. His unselfish and untiring efforts to serve mankind make him today the greatest of all living Americans.

President Herbert Hoover then delivered his address. He began by saying:

This is a unique opportunity for the nation to pay to Mr. Edison that tribute and that honor which lies in every heart, and an honor and a tribute not alone for the invention of the electric lamp, not only for the scores of other inventions with which he has endowed humanity, but because he has been a great American and he has lent distinction to every American citizen.

Talking of the lamp, the President emphasized that: 'It has become a friend of man and child.'

Then he discussed the method of invention of which Edison was the pioneer, the method which spurred those who followed to organize similar laboratories and to modernize them as progress advanced. He said, 'Mr. Edison was the pioneer in the determination of the new method of applied science, and now-a-days a thousand applied sciences laboratories have followed upon Menlo Park, supported by the industries of this country.'

The President then related in part:

Today the governments of the world levy upward of sixty billions of wealth founded upon electricity. But the taxes and the new wealth are not Mr. Edison's major accomplishment, nor the major accomplishment of men of his genius. They are the rivers of sweat saved from the backs of men, and the infinite drudgery relieved from the hands of women.

Mr. Edison's life has been one of constant toil.

Mr. Edison has ever been the exponent of research in both pure science and its application in the arts . . .

. . . in establishing this Institute, Mr. Ford is doing honor to Mr. Edison in a manner which appeals to our sense of fitness, and that is by founding an institution dedicated to education and scientific research.

It is indeed a generous act for a friend; it is a great service for the nation.

He then dwelt upon the importance of scientific research and its many stimulating ways in national life. He spoke of Edison, how he rose to leadership and how his life gives inspiration and confidence to every youth in our land where the door of opportunity still stands open. He was often interrupted by hearty applause.

Among the voluminous number of congratulatory messages that were received that night, Owen D. Young read one from His Royal Highness, the Prince of Wales; one from His Excellency, President von Hindenburg; one from Guglielmo Marconi; and one from Commander Byrd at Little America in Antarctica. It would have been impossible to have read them all. They came from all parts of the world, and from men and women well known in the professions.

On account of the slight collapse that Edison suffered, the President delayed his return trip to Washington until midnight, to be assured of his recovery.

I might also mention that approximately 400 millions of the special postage stamps were printed to commemorate the day.

On October 24, 1929, Mr. Ford took Edison to Detroit to inspect the Edison Electric Fountain that the municipality of the City of Detroit had built in Grand Circus Park. It was erected in honor of Edison, the great inventor and old-time Michigan newsboy.

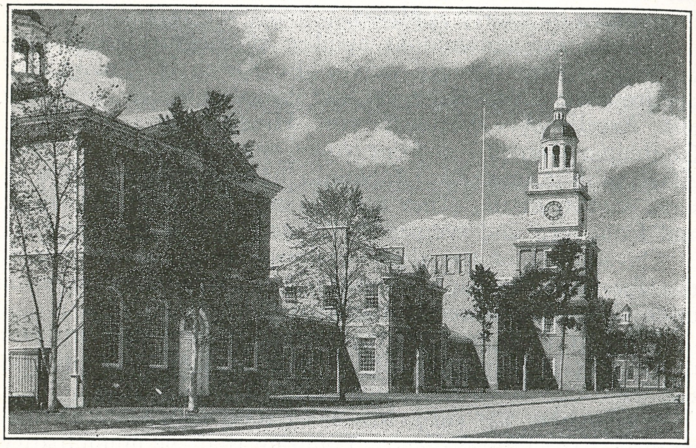
It would be impossible for me to go into detail on the many preliminary celebrations that took place with the official one at Dearborn. Such a movement had seldom before taken place; one man—Edison—was given tribute from mankind, irrespective of color, creed, or political affiliations. No personage had ever received such an ovation. If we borrow the word 'canonization' for the purpose and apply it to science, then surely Edison was canonized on October 21,

1929; he was recognized as a saint of progress by all creeds. All had recognized the benefactions that he had conferred on humanity; there existed no opposition. They all paid homage to this great American.

Thus ends the story of Edison in his Menlo Park laboratory, and how he there had harnessed an imponderable, intangible, invisible, canny, and intractable something that was called 'Electricity' and made it serve mankind beyond the dreams of the most sanguine.

Today that laboratory and The Edison Institute at Dearborn stand as a living monumental reminder of Edison's greatness.

(Editor's note—Mr. Jehl's manuscript ended at this point.)



The Edison Institute that was dedicated by Henry Ford in honor of Thomas A. Edison, at Dearborn, Michigan.

CVI. Conclusion

(Editor's Note—*On February 9, 1941, while he was at St. Petersburg, Florida, resting and recuperating his strength, Mr. Jehl was unexpectedly stricken and passed away. As a memorial on his passing, the Edison Pioneers prepared and sent to all its members the following tribute to the distinguished pioneer whose sincerity and enthusiasm for everything Edisonian had endeared him to all who came in contact with him at Menlo Park:*)

TRIBUTE OF THE EDISON PIONEERS

We hardly mourn his inevitable going so much as we rejoice
in pleasant memory at having been associated
with him in a great work for all
people under a great man

FRANCIS JEHL
at St. Petersburg, Florida
February 9, 1941

FRANCIS JEHL, one of the early Menlo Park 'boys,' was stricken on Saturday, February 8, and passed away the following day. The end came at St. Petersburg, Florida, where he had gone earlier in the winter in the hope of regaining his health following many months of illness.

Funeral services were held at Holcomb Funeral Home, Flemington, New Jersey, February 15. Interment was at Prospect Hill Cemetery, Flemington.

Mr. Jehl is survived by his wife; a son, Fred Jehl, of Budapest, Hungary, and a sister, Mrs. Ernest Lallear, of Brooklyn, New York.

Born September 6, 1860 at 1329 Chisholm Street, New York City, Francis Jehl while in his teens entered the employ of a law firm and it was through the instrumentality of one of its partners, Grosvenor P. Lowrey, that he was later to secure his chance with Edison. Study at Cooper Union and a year spent in the Phelps Western Union shop gave the youth an urge to go further in the electrical field and so it was that on February 18, 1879, Mr. Lowrey, prominent in the early days of the Edison electric light, penned a letter to Mr. Edison (still intact in the Edison records) in which an oppor-

tunity was sought for the ambitious youngster among the inventor's growing group of assistants.

Thus in the fore part of 1879 the name of Francis Jehl was added to the Edison pay roll at Menlo Park.

He was one of the laboratory assistants during the history-making days of the incandescent lamp and the development of a complete system of generation and distribution of electricity. From Menlo Park Jehl moved on to New York where, at the Goerck Street Edison Machine Works, he set up and supervised a testing room. Three years later, almost to the day on which Lowrey wrote his letter of introduction, Mr. Edison assigned Jehl to a European trip in the interest of the Edison system of electric lighting. More than forty years were to elapse before Mr. Jehl was to return home.

From 1882 to 1897 Mr. Jehl went about Europe introducing the Edison system. During this period he assisted in getting the works under way of the French Edison company. Just prior to this Jehl had installed a meter department at the English Edison company plant at Holborn Viaduct, which had but lately been completed by Edward H. Johnson, general manager, and William J. Hammer, chief engineer.

Among the prominent installations of that time was the plant installed for lighting the famed Brunn Theater in Austria. Other similar installations made under Mr. Jehl's supervision included that at Bucharest, Rumania. In 1883 Jehl opened an Edison exhibit at the Vienna Electrical Exposition.

At one time he was associated with the Hardtmuth Carbon Company of Austria, following which he was for about seventeen years chief engineer of the Budapest company. Stranded in Europe at the close of the World War, Mr. Jehl finally returned to the United States in 1922. For a time thereafter he assisted in the collection of Edisonia, most of which was later to form an important part of The Edison Institute at Dearborn, Michigan.

When Henry Ford recreated the Menlo Park atmosphere in his Greenfield Village he engaged Jehl to supervise the reconstruction of the old laboratory and to become curator of the Edison collection, which post he retained until his death.

Francis Jehl was an esteemed Member of

EDISON PIONEERS.

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